Phenomenological Research and Analysis

Authors:

Edwin C. May, Ph.D., Wanda L. W. Luke, and Nevin D. Lantz, Ph.D.

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Cognitive Sciences Laboratory

1010 El Camino Real, Suite 330, P.O. Box 1412, Menlo Park, CA 94025 • (415) 325-8292
Other SAIC Offices: Albuquerque, Boston, Colorado Springs, Dayton, Huntsville, Las Vegas, Los Angeles, McLean, Oak Ridge, Orlando, Palo Alto, Seattle, Tucson

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I. OBJECTIVE

The objective of this document is to provide a technical final report on tasks 6.2, "Basic Research," 6.3, "Applied Research," and 6.4, as listed in the 1991 Statement of Work. This report covers the time period from 4 February 1991 to 30 June 1992, and includes all subtasks.*

* This report constitutes the deliverable DI-MISC-80508 under contract number MDA908-91-C-0037.

II. BACKGROUND

With regard to this final report, anomalous mental phenomena (AMP) can be divided into two broad categories:*

- Anomalous Cognition (AC): A form of information transfer in which all known sensorial stimuli are absent.
- Anomalous Perturbation (AP): A form of interaction with matter in which all known physical mechanisms are absent.

For the purpose of this document, we define research that is primarily directed at understanding the nature of AMP (e.g., signal transmission, neurophysiology, etc.) as *basic*. Research that is primarily directed at improving the quality of output (e.g., analysis techniques, choice of target material, etc.) as *applied*. Basic and applied research domains are broad and are highly interactive and mutually supportive. Understanding the technical details of AC phenomena, for example, will improve its application potential, and likewise, being sensitive to the restrictions of a real-world problem may provide insight into underlying mechanisms.

1. Historical Perspective

Serious government research of AMP began in 1973 when a modest effort began at SRI International in Menlo Park, California, to determine if AMP could be verified and to assess the degree to which AMP could be applied in practical situations.

In fiscal year 1986, SRI International conducted the first coordinated, long-term examination of AC and AP phenomena. This program had three major objectives:

- Provide incontrovertible evidence for the existence of AC and AP.
- Determine the physiological and physical basis for AC and AP.
- Determine the degree to which AC data could be applied in practical situations.

The results and conclusions from this program were as follows:

- The first objective was partially met. An information transfer anomaly (i.e., AC) exists that could not be explained by inappropriate protocols, incorrect analyses, or fraud; however, there was insufficient evidence to conclude if AP existed.
- Significant progress was made in meeting the second objective. For example,
  (1) The central nervous system (i.e., the brain) of individuals with known AC ability appeared to respond to isolated AC stimuli.

* A definition of terms may be found in the Glossary in Section X on page 71.

LIST OF FIGURES

III. EXECUTIVE SUMMARY

During the course of this 18-month contract, we conducted five experiments that were designed to address specific issues of applied and basic research of AMP. Additionally, we conducted a variety of other investigations that did not require further experimentation. As an example of the latter, we applied fuzzy set theory to the data from one of the experiments. In this section, we provide a non-technical summary of the five experiments. Details on all tasks may be found in the body of the report.

A well-designed experiment provides valuable information regardless of the particular outcome. In our experimental effort during this contract, three studies produced positive outcomes and two did not. All, however, provided useful guidelines for a follow-on effort.

1. Target Dependencies

1.1 Abstract

The purpose of this experiment was to determine if the quality of AC depends upon an intrinsic target property, which is called the change of *entropy* (i.e., the amount of information contained in visual target material). This was examined for two different target types, photographs and short video clips. A second objective was to determine if the quality of AC depends upon a sender (i.e., a person who is isolated from the receiver but who is focusing upon the target material).

The experimental results indicate that the quality of AC does not require a sender to know about, or to focus his or her attention on, the target. Most importantly, we found a strong correlation between the quality of the AC and the change of entropy in a target: That is, the more information determined by information theory contained in the target, the better the AC. Should this result replicate in other experiments, it may be the first indication of an independent physical variable that is fundamental to AC. If so, this information can be used to vastly improve many other types of AC experiments.

1.2 Approach

Each of five receivers, who had previously demonstrated an AC ability, contributed 40 trials each. All receivers worked alone from their homes and, at a prearranged time, conducted an AC trial for a target that was located no less than 500 km away. The target was either a photograph from the *National Geographic* magazine or a short clip from a video movie. For half of the trials, the experimenter acted as a sender, and for all trials, the receivers were unaware of the target type or if there was a sender. After receiving the responses by facsimile machine, the experimenter mailed each receiver the target as feedback. Standard statistical procedures were use to determine whether there were differences in AC quality among these various conditions.

binary number target (i.e., one or zero). Sequential analysis is particularly sensitive to whether there is a "burst" of AC and can also determine to within statistical limits if no AC is present.

2.3 Results

The experienced receiver again produced significant evidence of AC of binary targets. That receiver's hit rate of 51.6% before the application of sequential analysis was improved to 76% as a result of the analysis. The other two receivers scored at chance expectation.

2.4 Conclusions

We confirmed earlier results that it is possible to enhance detection of AC with binary targets using sequential analysis. A major difficulty, however, is that the receivers had to register a guess (i.e. by pressing a computer mouse button) approximately 200 times for each sequential analysis trial. Thus the technique, while capable of enhancing the detection of AC of binary targets, is particularly inefficient due to excessive time expenditures.

3. AC in Lucid Dreams

3.1 Abstract

Throughout human experience, people have reported various types of AC in dreams, and laboratory experiments in the 1970s confirmed that AC may occur in dreams. A lucid dream is defined as one in which a dreamer becomes aware that she or he is dreaming. Extensive research has confirmed the existence of lucid dreaming, and that it is possible for the dreamer to signal the waking world about his or her knowledge about the dream.

The purpose of this pilot study was to determine if AC could occur during lucid dreaming. We found that AC can occur in lucid dreams. Because the dream-trials did not take place in the laboratory, there was some difficulty in interpreting the results; however, it was clear that lucid dreams do not inhibit AC functioning. Because of the success of this experiment, we will be repeating it in an appropriate sleep laboratory.

3.2 Approach

This experiment was designed as a pilot effort. Seven receivers, three experienced in lucid dreaming and four experienced as AC receivers, participated in the study. The four AC receivers were first trained in lucid dreaming before the AC trials began. During each trial, a target was selected randomly from the established pool of *National Geographic* magazine photographs and doubly sealed in two opaque envelopes. The dreamer/receiver placed the envelope next to the bed and was instructed, when a dream became lucid, to "open" the dream envelope (i.e., not the real envelope) while still dreaming, study its content, and report the experience upon waking. The target was provided as feedback once the data had been presented to the experimenter. Our standard rank-order analysis was performed to determine if AC occurred in the study. Since the trials were conducted in each receiver's own bedroom rather than under laboratory conditions, it was difficult to "induce" a lucid dream on demand. Thus, the total number of trials was small (i.e., 21).

stimuli). Our data contained substantial noise and, unfortunately, our analysis technique was so sensitive to it that any brain response to the isolated flashing lights would not have been observed. Fortunately, we have saved all the raw data from this experiment, so all that is required is to reanalyze the data with improved techniques. We are currently engaged in that task.

4.4 Conclusion

Until this new analysis is complete, we are unable to determine whether the brain responds to isolated stimuli. In the body of the report, we suggest that an improved protocol be implemented as part of the continuing research effort.

5. Enhancing the Detection of AC with Binary Coding

5.1 Abstract

The literature reports many attempts at using various statistical approaches to enhance the detection of AC. In this experiment, we used a standard technique from information theory (i.e., error correction through redundancy coding). We were unable to demonstrate that this particular procedure was successful. As a result of this experiment, we identified a number of improvements that might be applied in new studies. For example, in our study, the statistical technique required special targets, which have not been part of our usual collection. A replication will use a pool of targets that have been successfully used in other experiments. We also learned that our statistical procedure was not sensitive to correct AC responses that happened not to be part of the statistical procedure. We have identified a number of new approaches that correct this problem.

5.2 Approach

Five receivers, who had previously demonstrated AC ability, contributed eight trials each. For each trial, all receivers worked alone from their homes and, at a convenient time, conducted an AC trial for a target that was located no less than 500 km away. The targets, which were photographs from the *National Geographic* magazine, were chosen in accordance with specific design criteria and were available for one week for each trial. To use error correcting coding, we identified a series of questions that pertained to the presence or absence of specified target elements. In this way, a target element, for example *water*, could correspond to a single binary bit in the error correcting code. That is, if *water* were present in the target, the value of one would be assigned to it, otherwise it would be assigned a value of zero. We created ten different sets of five target elements and chose photographs that matched the presence/absence criteria. The presence or absence of particular target elements was dictated by the requirements of the 5-bit binary error correcting code that we used in this study. The principle behind error correcting coding in an AC application is that a receiver could "miss" one of the target elements but still arrive at the correct target. Error correction is a common technique found in the computer industry and in deep space communications. We were adapting its use for AC experiments.

After a receiver had completed an AC trial, the response was sent by facsimile to an experimenter in our laboratory in Menlo Park, CA. By return facsimile, the receiver was sent five questions that required yes/no answers for the presence or absence of the target elements. Upon the receipt of the completed questionnaire, the experimenter sent the photograph back as feedback.

IV. TARGET DEPENDENCIES

This section comprises the final report for SOW items 6.2.2.1 and 6.2.2.2.

1. Objective

There are two objectives of this pilot study:

(1) Explore the effects of target properties on AC quality.

(2) Determine the degree to which AC quality depends upon a sender.

2. Introduction

The field of parapsychology has been interested in improving the quality of responses to target material since the 1930's, when J. B. Rhine first began systematic laboratory studies of extra sensory perception. Since that time, much of the field's effort has been oriented toward psychological factors that may influence AC. In this section, we review the pertinent literature that categorizes targets that have been used successfully in AC experiments.

At a recent conference, Delanoy reported on a survey of the literature for successful AC experiments.[1] She categorized the target material according to perceptual, psychological, and physical characteristics. Except for trends related to dynamic, multi-sensory targets, she was unable to observe systematic correlations of AC quality with her target categories.

Watt examined the AC-target question from a psychological perspective.[2] She concluded that the best AC targets should be those that are psychologically meaningful, have emotional impact, and contain human interest; those targets that have physical features that stand out from their backgrounds or contain movement, novelty, and incongruity also should be good targets.

The difficulty with both the survey of the experimental literature and the psychologically oriented theoretical approach is that understanding the sources of the variation in AC quality is problematical. Using a vision analogy, energy sources of visual material are easily understood (i.e., photons); yet, the percept of vision is not well understood. Psychological and possibly physiological factors influence what we "see." In AC research, the same difficulty arises. Until we understand what factors influence the AC percept, results of systematic studies of AC are difficult to interpret.

Yet, in a few cases, some progress has been realized. In 1990, Honorton et al. conducted a careful meta-analysis of the experimental Ganzfeld literature.[3] In Ganzfeld experiments, receivers are placed in a state of mild sensory isolation and asked to describe their mental imagery. After each trial, the analysis is performed by the receiver, who is asked to rank order four pre-defined targets, which include the actual target and three decoys; the chance first-place rank hit rate is 0.25. In 355 trials collected from 241 different receivers, Honorton et al. found a hit rate of 0.31 ($z = 3.89$, $p \leq 5 \times 10^{-5}$) for an effect

Because the historical database included trials with and without senders, we explored the effects of a sender on AC quality, as well.

3. Approach

3.1 Target-pool Selection

The static target material for this pilot study was a set of 50 *National Geographic* magazine photographs. This set was divided into 10 sets of five photographs that were determined to be visually dissimilar by a fuzzy set analysis.[7] The dynamic target material was four sets of five 60 to 90 second clips from popular video movies. These clips were selected because they had the following characteristics:

- Were thematically coherent.
- Contained obvious geometric elements (e.g., wings of aircraft).
- Were emotionally neutral in that they did not contain obvious arousing material.

The intent of these selection criteria was to control for cognitive surprise, to provide target elements that are easily sketched, and to control for psychological factors such as perceptual defensiveness.

3.2 Target Preparation

The target variable that was considered in this experiment was the total change of Shannon entropy per unit area, per unit time. We chose this quantity because it was qualitatively related to the "information" contained in the target types shown in Table 1, and because it represented a potential physical variable that is important in the detection of traditional sensory stimuli. In the case of image data, the entropy is defined as:

$$S_k = -\sum_{j=0}^{N_k-1} p_{jk} log_2(p_{jk}), \equiv 0 \text{ if } p_{jk} = 0,$$

where p_{jk} is the probability of finding image intensity j of color k. In a standard, digitized, true color image, each pixel (i.e., picture element) contains eight binary bits of red, green, and blue intensity, respectively. That is, N_k is 256 (i.e., 2^8) for each k, $k = r, g, b$. The total change of the entropy in differential form is given by:

$$dS_k = |\nabla S_k| \cdot \vec{dr} + \left|\frac{\partial S_k}{\partial t}\right| dt. \tag{1}$$

That is, the total change of Shannon entropy is the change because of spatial variations in the static targets added to the change resulting from frame-to-frame variations in the video targets.

We must specify the spatial and temporal resolution before we can compute the total change of entropy for a real image. Henceforth, we drop the color index, k, and assume that all quantities are computed for each color and summed.

3.2.1 Static Targets

To select the 50 static targets, 100 *National Geographic* magazine photographs were scanned at 100 dots per inch (dpi) for eight bits of information of red, green, and blue intensity. At one centimeter spatial resolution, this scanning density provides 1,550 pixels for each 1-cm^2 macro-pixel to compute the p_j.

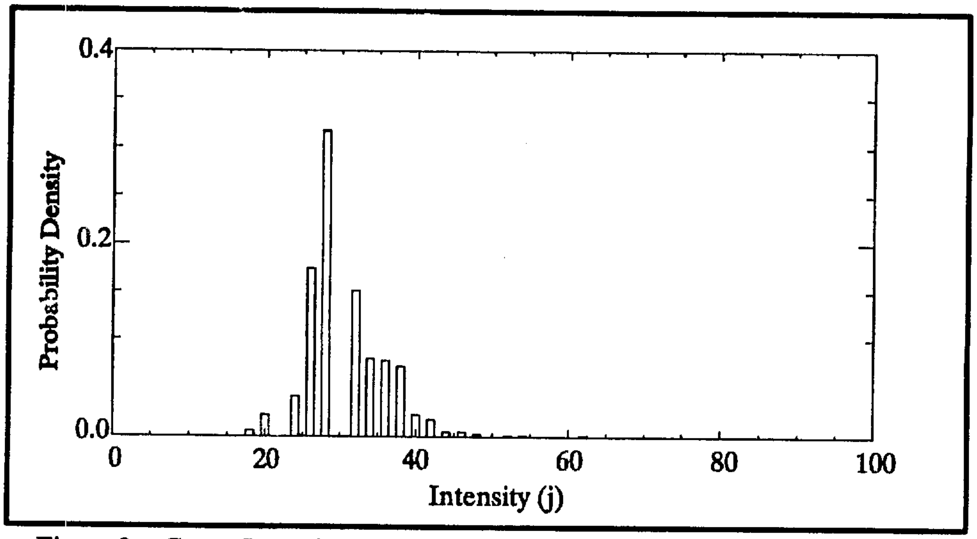


Figure 2. Green Intensity Distribution for the City Target (Macro-pixel 3,3)

We used a standard algorithm to compute the 2-dimensional spatial gradient of the entropy. Figure 3 shows contours of constant change of entropy (calculated from Equation 1) for the city target. The total change per unit area is 1.88 bits/cm.*

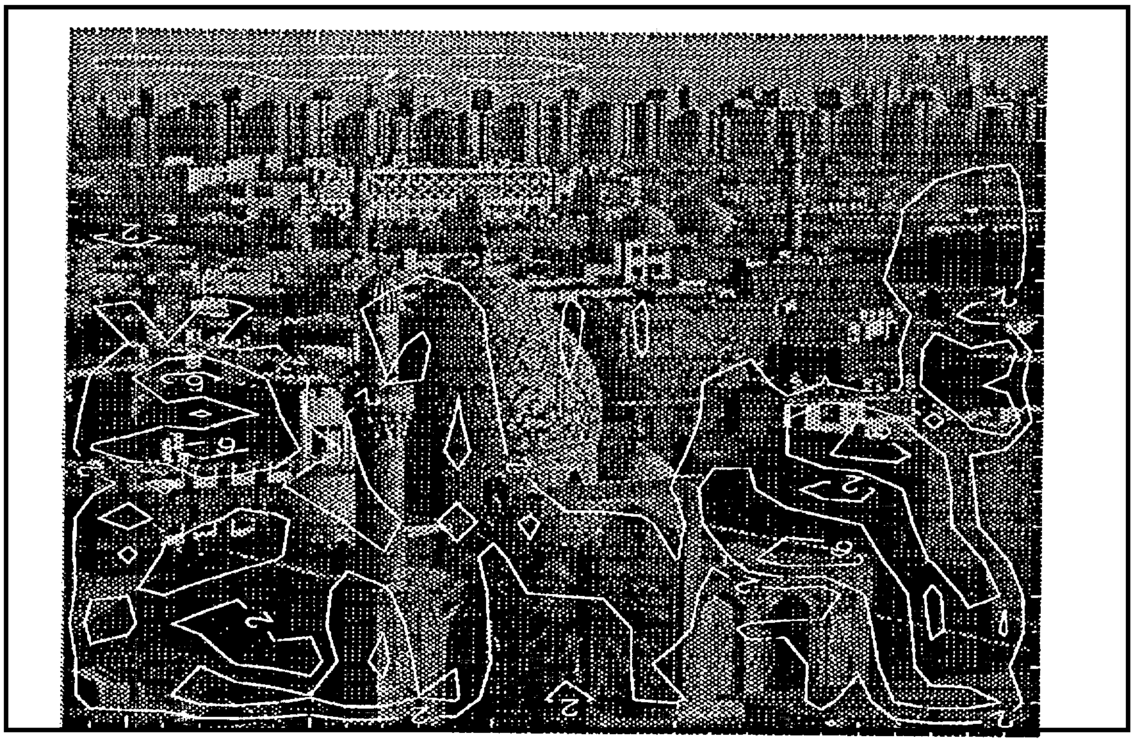


Figure 3. City with Mosque ($|\Delta S| = 1.88$ bits)

The city target was chosen as an example because it was known (qualitatively) to be a "good" static photograph for AC trials in earlier research. Figure 4 shows contours of constant change of entropy for a photograph that was known not to be a "good" AC target.

* In this formalism, entropy is in units of bits and the maximum entropy is 24 bits.

$$\frac{\partial S_{ij}}{\partial t} \approx \frac{\Delta S_{ij}(t)}{\Delta t} = \left| \frac{S_{ij}(t + \Delta t) - S_{ij}(t)}{\Delta t} \right|, \tag{2}$$

where Δt is one over the digitizing frame rate (i.e., one second). We can see immediately that the dynamic targets have a larger ΔS than do the static ones because Equation 2 is zero for all static targets.

3.2.3 Cluster Analysis

Using Equations 1 and 2, we computed ΔS for all the static and dynamic targets. These targets were grouped, using standard cluster analysis, into relatively orthoginal clusters of relatively constant ΔS. Fuzzy set analysis and inspection were used to construct packets of five *visually* dissimilar targets from within each cluster. Our interim report, which is dated 15 February 1992, details the cluster analysis.[8] Figures 6 and 7 show the clusters from that report for the dynamic and static targets, respectively.

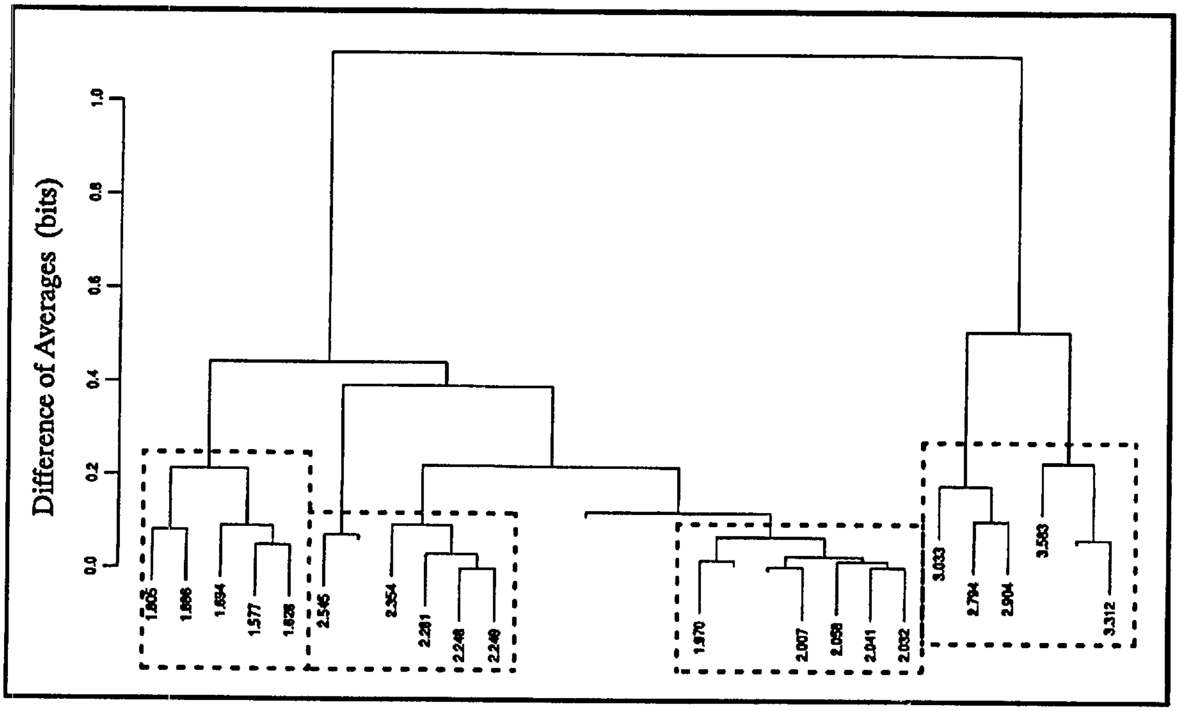


Figure 6. Cluster Diagram for Dynamic Targets

For ease of reading, Figure 7 shows only those 50 static targets that were used to form the constant entropy clusters, rather than the whole set of 100. We show the computed ΔS at the end of each cluster leaf.

3.3 Target Selection

For a specified target type (e.g., static photographs), a target pack was selected randomly and one target of the five within that pack was also chosen randomly.

3.4 Receiver Selection

Each of five experienced receivers, who have produced significant AC effect sizes in previous investigations, contributed 40 AC trials (i.e., ten trials under each of the conditions shown in Table 2). Two of the receivers resided in California while the other three resided in Kansas, New York, and Virginia.

Table 2

Experiment Conditions

Condition	Target Type	Sender
1	Static	Yes
2	Static	No
3	Dynamic	Yes
4	Dynamic	No

3.5 Sender Selection

The sender for all trials was the principal investigator (PI), who was in Lititz, Pennsylvania.

3.6 Session Protocol

3.6.1 Target Preparation

Prior to beginning the experiment, an experiment coordinator randomly generated a unique set of 20 static and 20 dynamic targets for each of the five receivers. After a target was selected, it was immediately returned to the pool of possible targets and so could be used again. Within each target type, a counter balanced set of sender/no sender conditions was also generated. A copy of each target was placed in an envelope and a trial number, 1 through 40, was written on the outside. Those envelopes containing targets from the no-sender condition were sealed while those for the sender condition remained unsealed. Each set of 40 targets was packaged separately and shipped to the PI in Pennsylvania.

3.6.2 Trial Schedule

The experiment was conducted over a five month period. Individual schedules were developed with each receiver so as to cause as little inconvenience to their daily routine as possible.

3.6.3 Session Sequence

For each trial and for each receiver, the PI proceeded as follows:

- Selected the appropriately numbered envelope from the box for the appropriate receiver.
- In the sender condition, looked at the selected target for 15 minutes and attempted to "transmit" it to the intended receiver during that time period.
- In the no-sender condition for the static targets, placed the unopened envelope on an uncluttered desk in the PI's office for the 15 minute trial period. In the no-sender condition for the dynamic targets, played the video repeatedly for 15 minutes with the sound turned off and the TV monitor in another room.
- At the conclusion of the 15 minute trial period and after the receipt of the receiver's response by facsimile, sent a copy of the target material (i.e., either a photograph or video tape) to the receiver by mail.

3.7.3 Post-Hoc Assessment

Rank-order analysis does not usually indicate the absolute quality of the AC. For example, a response which is a near-perfect description of the target receives a rank of one. Yet a response which barely matches the target, may also receive a rank of one. Table 3 shows the rating scale that we used to perform a *post hoc* assessment of the quality of the AC responses regardless of their rank. The quality of an AC response is defined as its visual correspondence with the intended target.

Table 3.

0-7 Point *Post Hoc* Assessment Scale

Score	Description
7	Excellent correspondence, including good analytical detail, with essentially no incorrect information.
6	Good correspondence with good analytical information and relatively little incorrect information.
5	Good correspondence with unambiguous unique matchable elements, but some incorrect information.
4	Good correspondence with several matchable elements intermixed with incorrect information.
3	Mixture of correct and incorrect elements, but enough of the former to indicate receiver has made contact with the target.
2	Some correct elements, but not sufficient to suggest results beyond chance expectation.
1	Very little correspondence.
0	No correspondence.

To apply this subjective scale to a target-response trial, an analyst begins with a score of seven and determines if the description for that score is correct. If not, then the analyst tries a score of six and so on. In this way the scale is traversed from seven toward zero until the score-description is correct for the trial.

Figures 8 through 10 illustrate the application of this scale and show that the quality of an AC response is not necessarily indicated by its first-place rank. All three examples were given a rank of one in a blind analysis. These examples were chosen from the experiment which is being described in this section (i.e., Section IV). The response to the waterfall target in Figure 8 included a number of pages of material about a city and other man-made activity. In all of our analyses, we strictly adhere to the concept that any material a receiver deletes from the response prior to feedback is not counted in the analysis. Thus, the response in Figure 8 is considered as complete. The other examples are shown in their entirety.

The scale shown in Table 3 can be divided into two sections, 0-3 and 4-7. The upper portion of the scale indicates clear contact, presumably by AC means, with the intended target material, while the remainder of the scale indicates little or no contact.

We used this scale to provide assessment scores to examine the correlation with the target entropy.

4. Hypotheses

4.1 Null Hypothesis

The overall null hypothesis was that $\bar{\varepsilon} = 0$.

4.2 Sender and Target Condition

Using an F-test we tested the hypothesis that the quality of AC does not depend upon a sender regardless of target type. Similarly, we used an F-test to test the hypothesis that the quality of AC does not depend upon target type regardless of the sender condition.

The ANOVA also tests for potential interactions between the target and sender conditions. For example, it might be that a sender is required for dynamic targets and not for static ones.

4.3 Target Entropy

The AC quality (i.e., scores greater than three from the *post hoc* scale in Table 3) of each trial was correlated with target ΔS. A significant correlation would indicate that target entropy and AC quality may be linearly related.

5. Results and Discussion

5.1 Effect Size Analysis

Five receivers completed 40 trials each. Table 4 shows the effect sizes (i.e., $z/\sqrt{n}$) computed for the 10 trials in each cell. The shaded cells indicate 1-tailed significant results. Receiver 009 showed significant evidence for AC in the static target, no-sender condition ($p \leq 0.02$); receiver 372 in the static target, sender condition ($p \leq 0.01$); and receiver 518 in the static target, no-sender condition ($p \leq 0.05$). See the underscored values in Table 4.

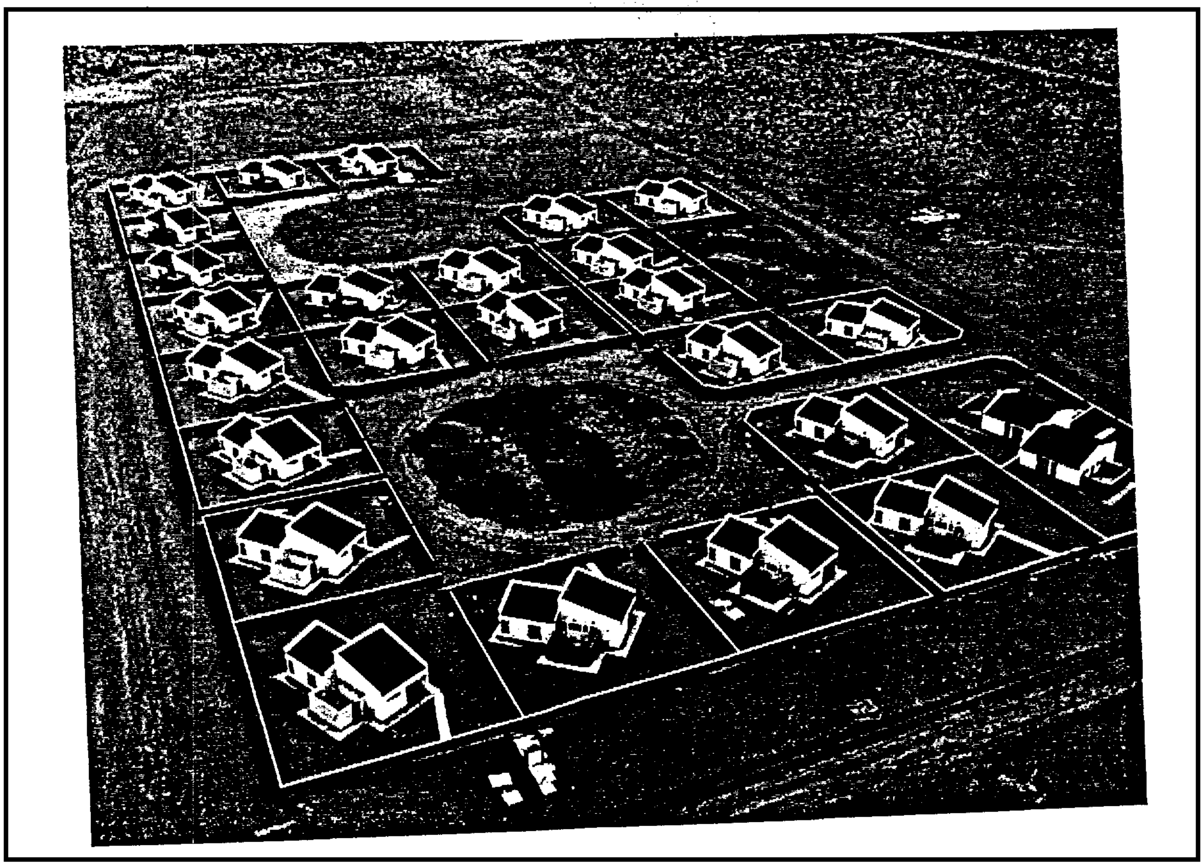
Table 4.

Effect Sizes

Receiver	Sender Static	No Sender Dynamic	No Sender Static	Sender Dynamic
009	−0.071	0.141	0.636	−0.141
131	−0.071	0.495	−0.071	0.212
372	0.707	−0.283	0.141	−0.354
389	0.141	0.000	0.212	0.000
518	−0.088	0.283	0.530	−0.495

5.2 Analysis of Variance

Table 5 shows the results of an ANOVA on these data. Since there were 10 trials within each cell, the degrees of freedom are the same for all receivers and, therefore, are only shown in the column headings. Two receivers show significant main effects. Receiver 372 showed a tendency to favor static over dynamic targets (i.e., $p \leq 0.03$), and receiver 518 showed a tendency to favor no sender (i.e., $p \leq 0.04$).



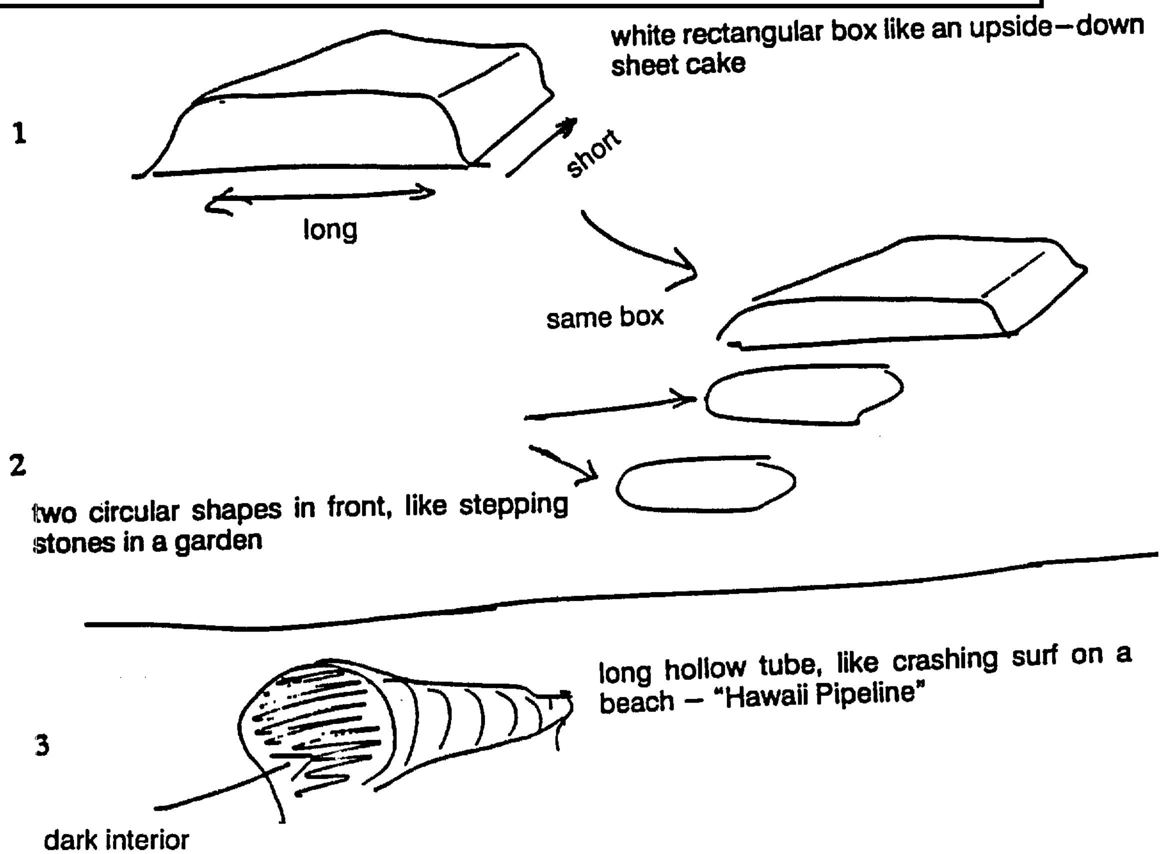


Figure 9. Target and Response with a *Post Hoc* Rating of 4

fices to say, however, that the sigma-count (i.e., the sum of the membership values over all 131 visual elements) for each target is proportional to its visual complexity. A list of these target elements may be found in Appendix A.

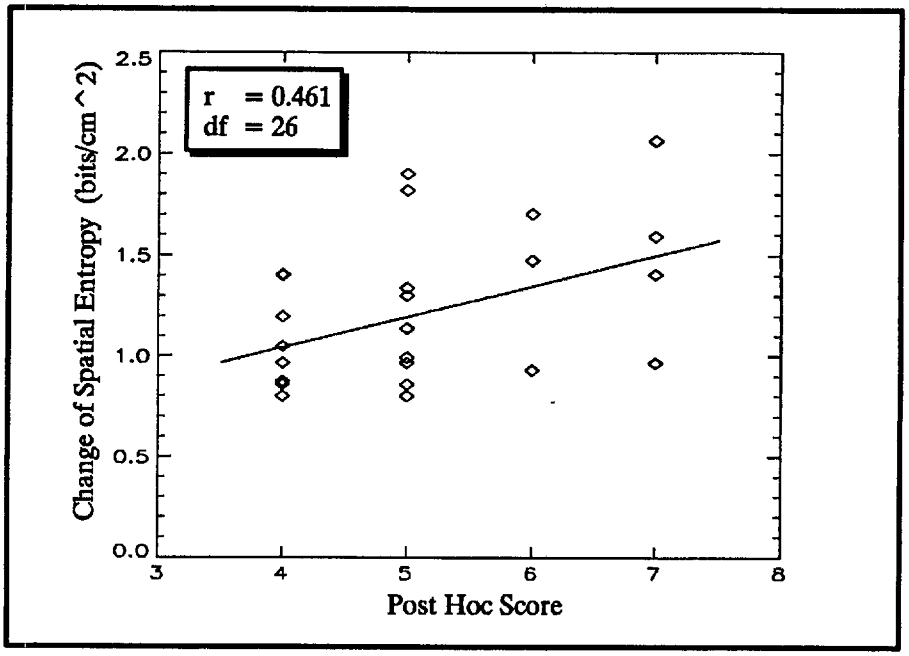


Figure 11. Correlation of *Post Hoc* Score with Static Target ΔS

We computed the liner correlation coefficient for target complexity with the assigned *post hoc* rating. For all 100 static targets used in this study we found $r = 0.049$, $df = 98$, and for target complexity with the measured ΔS, we found $r = -0.031$, $df = 98$.*

On closer inspection neither of these small correlations is surprising. While it is true that an analyst will find more matchable elements in a complex target, so also are there many elements that do not match. Since the rating scale (i.e., Table 3) is sensitive to correct and incorrect elements, the analyst is not biased by visual complexity.

The change of Shannon entropy is derived from the intensities of the three primary colors (i.e., Equation 1 on page 13) and is unrelated to large-scale objects or meaning, which is inherent in the definition of visual complexity. Thus, we would not expect a correlation between ΔS and visual complexity.

Visual complexity, therefore, cannot account for the correlation shown in Figure 11; thus, we are able to conclude that the quality of an AC response depends upon the spatial information (i.e., change of Shannon entropy) in a static target.

A single analyst scored the 100 responses from the dynamic targets using the *post hoc* scale in Table 3. Figure 12 shows the scatter diagram for the *post hoc* scores and the associated ΔS for the 24 trials with a score greater than three for the dynamic targets. We found a linear correlation of $r = 0.043$, $df = 22$.

* Using just the 28 data points in Figure 11, we find $r = -0.216$, $df = 26$ and $r = 0.003$, $df = 26$ for the correlation with the *post hoc* score and ΔS, respectively. Since these correlations are negative or very small, they do not alter the conclusion.

in space, a nature segment on the Grand Canyon, and a James Bond thriller can be included in the same target pool. Conversely, the well-known Zener cards represent a vary narrow target bandwidth. The static targets, which are constructed from a collection of *National Geographic* magazine photographs, represent an intermediate bandwidth; the size and general content of the material is roughly the same throughout the pool.

We hypothesize that the bandwidth of the target pool is a source of *intrinsic* noise in the receiver. We assume that the information that is gained by AC is small compared to other sensory mechanisms, and the primary mental task for a receiver is to discriminate the AC data from internally generated, target-unrelated information. For large bandwidth target pools that may contain almost anything, a receiver is unable to censor his/her internal experience. Thus, target-related and target-unrelated material are equally reported; therefore, large bandwidth pools are extrinsically noisy. Small bandwidth pools are also extrinsically noisy but for a different reason. If a receiver is cognizant of all of a limited set of target elements (e.g., Zener cards), then he/she has an internal discrimination problem. All target possibilities are experienced with equal intensity because of knowledge about the pool and vivid short-term memory. Assuming there is weak AC information about the specific target, then target-extrinsic noise is generated because of the very low signal-to-noise ratio.

Most of our receivers have participated in many earlier experiments which used the static target pool, and were unfamiliar with target pools with large bandwidths such as the dynamic pool. Historically, we have observed AC effect sizes for static targets 50% to 100% larger than we found in this experiment. The current protocol did not include monitoring the AC trials, and the receivers were blind to the target type. It is impossible to determine from this experiment which factor was predominant, but if the bandwidth argument is correct, we would expect a decrease in functioning for even the static targets because receivers would not be able to self-censor their responses.*

We recommend that a new target pool be developed that limits the bandwidth of the dynamic targets and that the static targets be specific frames from within the dynamic target pool. In this way, we can control for target bandwidth effects between the target types. We recommend that a new experiment be conducted with these new target pools.

5.4 Overall Conclusions

Based upon the results of this pilot experiment, we provide the following tentative conclusions:

- The ANOVA results suggest that a sender is not fundamentally required for AC.
- Subject to the caveat suggested in the previous section, the ANOVA results suggest that AC quality does not depend upon target type.
- AC quality for static targets is proportional to a target's spatial information (i.e., ΔS).

Because of the importance of determining if ΔS is an intrinsic target property for all AC targets, we urge that this study be repeated with the improvements discussed above.

* It is important to recognize that limited, or even complete, knowledge of the target pool cannot bias the blind rank-order statistic because it is a differential measure within the pool. It may, however, change the mean of the *post hoc* scores, but correlations are insensitive to means. Thus, correlations based upon the *post hoc* assessment remain valid.

V. ENHANCING DETECTION OF AC OF BINARY TARGETS

This section constitutes the final report for SOW item 6.2.3.3.

1. Objective

The objective of this investigation was to replicate and extend an earlier study that enhanced the detection of AC of binary targets.

2. Background

In 1984, Puthoff used a majority vote procedure to statistically enhance the detection AC of binary targets.[9] The chance probability of guessing a binary target correctly is 0.50. In Puthoff's experiment, his best receiver, using AC methods, increased the probability to 60%. Using a majority vote of five guesses per bit, the probability of guessing the target correctly was increased by 18.3% from 60 to 71 percent.

In fact, if the probability of guessing a binary target is given by

$$p = p_0 + \delta, \tag{4}$$

where δ is a non-negative constant much, much less than unity and $p_0 = 0.5$, then it can be shown that a majority vote procedure is the most efficient method for obtaining an arbitrarily accurate guess. Let n be the number of bits in a majority vote procedure (i.e., n is assumed to be odd). Then the majority vote probability is given by a binomial sum as:

$$P(n) = p^n + \binom{n}{n-1} p^{n-1}(1-p) + \cdots + \binom{n}{\frac{n+1}{2}} p^{\frac{n+1}{2}}(1-p)^{\frac{n-1}{2}},$$

where p is the single bit probability given by Equation 4. By choosing n large, $P(n)$ can approach unity.

The problem is that a majority vote procedure is predicated on the assumption that ε is not a function of time, an assumption that is known not to be true in AC experiments. Ryzl attempted to solve this problem by modifying a majority vote scheme to include on-line checks.[10] He was able to demonstrate a 100% accurate guess of 15 decimal digits encoded as 50 binary digits ($p = 10^{-15}$).

In 1985, Puthoff, May, and Thomson used a well-known technique called sequential analysis (SA) and, for one receiver, realized a 3.7% enhancement 53.6 to 55.6 percent in a binary AC experiment.[11] Differing from the usual statistical analysis, SA does not require that the sample size be specified in advance; however, by adjusting certain SA parameters, it is possible to set the expected number of trials in the processes.

$$OC(p) = 1 - \frac{\left(\frac{1-\beta}{\alpha}\right)^h - 1}{\left(\frac{1-\beta}{\alpha}\right)^h - \left(\frac{\beta}{1-\alpha}\right)^h}, \text{ where } p \text{ is given by}$$

$$p(h) = \frac{1 - \left(\frac{1-p_1}{1-p_0}\right)^h}{\left(\frac{p_1}{p_0}\right)^h - \left(\frac{1-p_0}{1-p_1}\right)^h}, \text{ where } -\infty \le h \le +\infty. \tag{7}$$

3.2 A Two--tailed Example of Sequential Analysis

In this section we modify the formalism of SA to include a measure of the difference between the accumulated number of ones and the expected number of ones. This will allow a two-tailed application of SA. The only mo^dification that is necessary to Equation 5 is that the slope, a, is now given by:

$$a = \frac{\ln\left(\frac{1-p_0}{1-p_1}\right)}{\Delta} - p_0. \tag{8}$$

In this example we assume that $\alpha = \beta$, so that the curves (see Figure 13) that define the decision algorithm are symmetric. Let δ be the accumulated excess number of ones (i.e., the number of ones minus the expected number of ones). In the two-tailed case, the two hypotheses that are tested by SA become $H_0: p = p_0$, and $H_1: p = p_1$ or $p = 1 - p_1$.

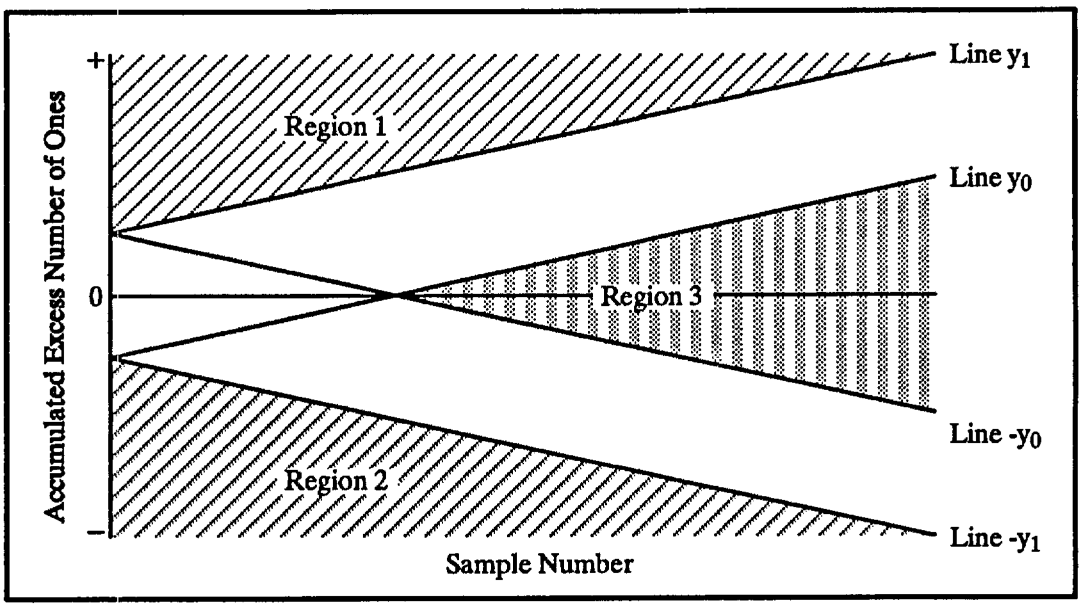


Figure 13. Two-tailed SA Decision Graph

When δ enters either Region 1 or 2, stop the sampling and assume H_1 is true with a Type II error of β. Likewise, if δ enters Region 3, stop the sampling and assume H_0 is true with a Type I error of α.

3.3 Hypotheses

The two hypotheses that were tested in this experiment are:

(1) $H_0: p = p_0 = 0.5$, and

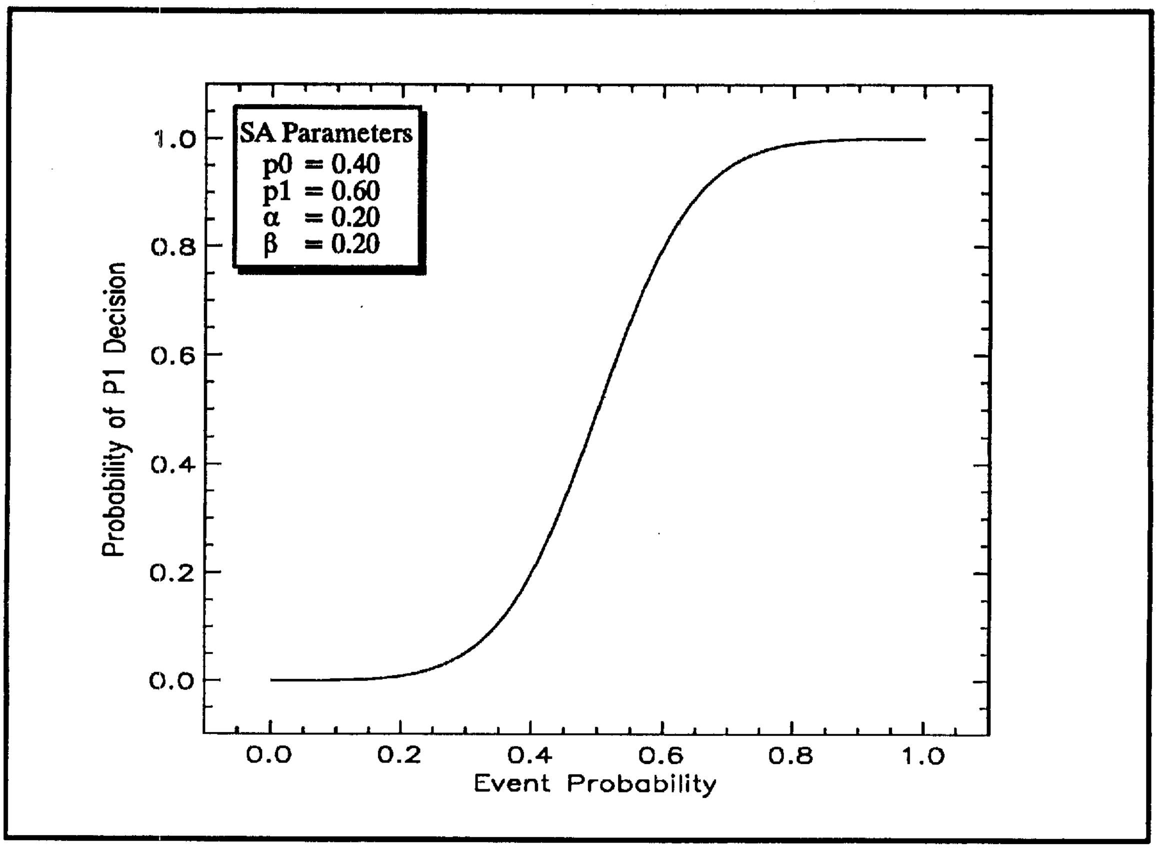


Figure 15. Operating Characteristic Function — 2-Tail

3.4 Protocol

3.4.1 Receiver Selection

Three receivers participated in this study. One (receiver 531) was selected because that individual had produced statistically significant results in earlier similar experiments.[12,13] Two receivers (7 and 83) were selected because of their interest and because of successes in free-response AC experiments.

3.4.2 Target Selection

A Sun Microsystem's SPARC workstation used a feedback shift register algorithm to generate a single binary target for each SA decision trial.[14]

3.4.3 Trial Definition

A trial was defined as an assertive SA decision. That is, either $p = p_1$ or $p = 1 - p_1$. Decisions resulting in $p = p_0$ were tabulated, but otherwise ignored. Each receiver contributed 100 trials.

3.4.4 Sample Definition

An experimental control program oscillated a single binary bit between one and zero as rapidly as possible. When a mouse button was pressed, the state of that oscillating bit represented the value of the single sample.

Table 7

Receiver 83

Analysis Method	Hits	Trials	Rate	Z-Score	ε
Sequential Analysis	44	100	0.440	−1.20	−0.120
Binomial (decision)	1,916	3,966	0.483	−2.13	−0.034
Binomial (all)	9,422	18,937	0.498	−0.68	−0.005

Receiver 83 produced an overall score of mean chance expectation.

Table 8

Receiver 531

Analysis Method	Hits	Trials	Rate	Z-Score	ε
Sequential Analysis	76	100	0.760	5.20	0.520
Binomial (decision)	2,842	5,059	0.562	8.79	0.124
Binomial (all)	11,008	21,337	0.516	4.65	0.032

Receiver 531 produced an overall significant score (i.e. $Z = 5.2, p \leq 1 \times 10^{-7}, \varepsilon = 0.52$). This receiver is experienced at computer tasks and the result is consistent with his historical performance. A raw hit rate of 0.516 is what is usually seen,[12] and the effect size of 0.032 is consistent with other forced choice AC experiments.

Although only one receiver of three produced significant evidence of AC, the result is illustrative of the technique, and because of 531's previous performance, we consider that this result is not likely to be spurious. While a 16-fold enhancement of effect size was realized by the SA method, it is particularly inefficient; to obtain 100 decisions, 531 pressed the mouse button 21,333 times for an efficiency of 0.47%. It is possible that the efficiency could be improved if the basic SA method could include some adaptive method. That is, the parameters of the analysis could be modified on the basis of the recent scoring rate. If sufficient improvement could be realized, this method might be incorporated as an aid in decision making in practical applications.

VI. MAGNETOENCEPHALOGRAPH

This section comprises the final report for SOW item 6.2.1.

1. Introduction

In a series of electroencephalograph (EEG) experiments conducted at SRI International beginning in 1974, the central nervous system (CNS) of individuals was found to respond to remote and isolated visual stimuli (i.e., a flashing light).[15,16,17] In the first experiment, during randomly interleaved 10-second epochs (i.e., trials), either a flashing light (16 Hz) or no light was present in a sensorially and physically isolated room. Significant decreases of occipital alpha power of isolated receivers were observed by Rebert and Turner.[15] Two replications were conducted in collaboration with Galin and Ornstein at the Langley Porter Neuropsychiatric Institute. As reported by May et al., the results were inconclusive; the first replication confirmed the Rebert and Turner finding, a decrease of alpha power concomitant with the flashing light, but the second replication attempt found an increase in alpha power.[17]

Under another program in FY 1988, SRI International and a biophysics group at a national laboratory conducted an experiment using the magnetoencephalograph (MEG) technique. This experiment was designed as a conceptual extension of the May et al. EEG experiment, although there were significant differences in the protocol. Two types of stimuli were randomly presented to an isolated sender while MEG data were collected from a receiver. The experimental stimulus (i.e., remote stimulus) was a 5-cm square, linear, vertical sinusoidal grating lasting 100 milliseconds. The second stimulus, a control stimulus (i.e., pseudostimulus), was simply a time marker corresponding to a blank screen in the data stream, and was also presented to the sender. There was no change in the alpha power, as reported by May et al., but a *post hoc* analysis revealed a root-mean-square average phase shift of the dominant alpha frequency.[18] A key result of that experiment was that similar "anomalous" phase shifts were obtained for the remote stimuli and the pseudostimuli. Three candidate explanations for these results were suggested. The observed phase shifts might have been:

- Spurious (i.e., statistical deviations within chance expectations)
- Electromagnetic artifacts
- Evidence of anomalous cognition

In order to determine which of these three candidate explanations was correct, we replicated the study at the national laboratory as part of this current effort.

either the RS or PS; and reset the buffer pointers after 100 ms (i.e., the stimulus duration = 100 ms). Figure 16 shows this sequence in graphical form.

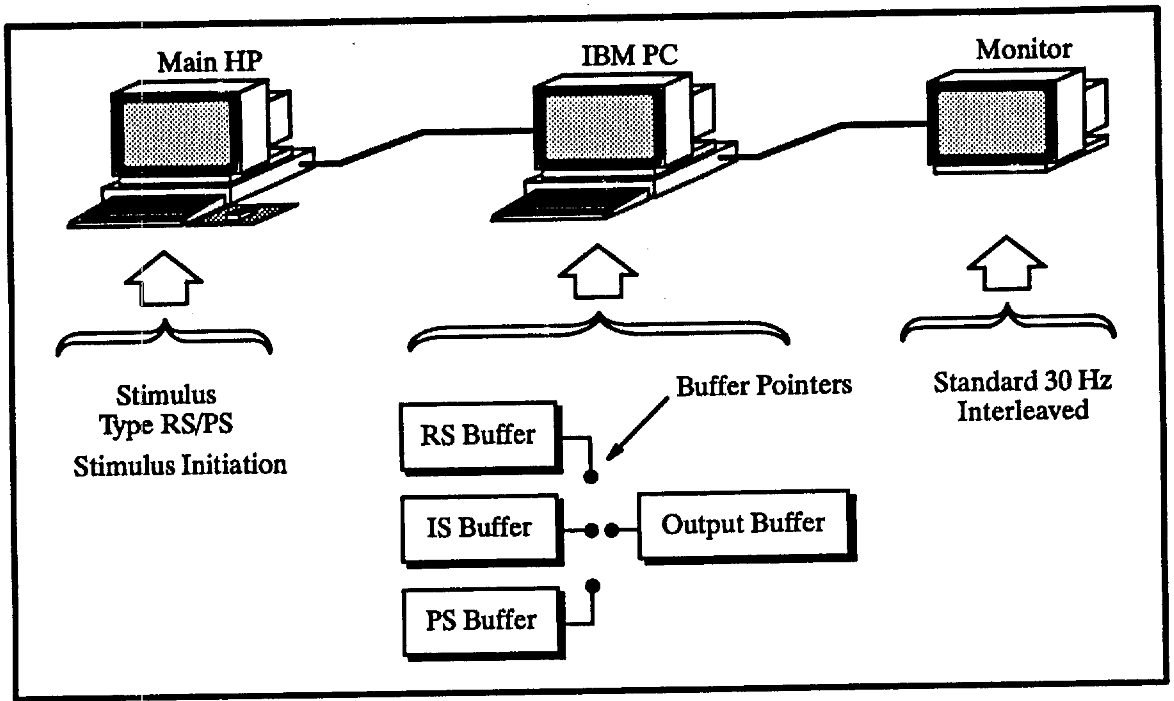


Figure 16. Sequence of Events for Stimuli Generation

2.1.5 Placement of the Seven-Sensor MEG Array

The placement of the seven-sensor MEG array was determined by an individual receiver's response to a direct light stimulus. While being stimulated by randomly interleaved low and high spatial-frequency gratings, sufficient stimuli (e.g., 30 to 50 of each type) were collected to produce good signal-to-noise responses. The position of the sensor array, relative to head-based coordinates, was recorded manually on a skull cap, so that the array could be repositioned accurately during subsequent experimental blocks. The array positions that were used during the RS blocks were determined by the maximum response to these direct stimuli. For this portion of the experiment, the stimuli were generated three to four times faster (i.e., ≈ 1 per second) than in the AC portion of the experiment.

2.1.6 Session Protocol

The session protocol was a follows:

(1) Using the marking on the skull cap, the MEG array was repositioned as close as possible to the original calibration location.

(2) Its position was confirmed with direct stimuli, and adjustments were made, if they were necessary.

(3) The designated sender was positioned in front of the remote monitor, which was located approximately 40 m from the receiver.

(4) The video monitor, which presented the direct stimuli, was turned off.

(5) The receiver was instructed to relax with eyes closed. In addition, the receiver was given a few possible strategies that included focusing attention on the display that the sender was observing, on the sender, or on both.

(6) The receiver was notified, by intercom, that the run was about to begin.

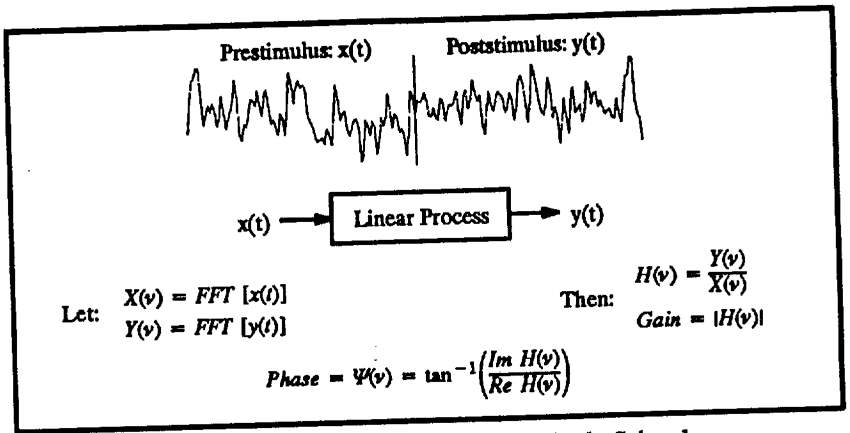


Figure 17. Phase Calculation for a Single Stimulus

Statistics (e.g., p-values, z-scores) were computed from the distribution of RMS phases derived from the Monte-Carlo-pass distribution.

Conceptually, a 2-tailed z-score was calculated from a Monte Carlo distribution of phase shifts in the following way: Let μ_Ψ and σ_Ψ be the mean and standard deviation of the Monte Carlo phase shift distribution, and Ψ_0 be the observed RMS phase shift. Since the distribution of averages is approximately normal, compute:

$$z = \left|\frac{\Psi_0 - \mu_\Psi}{\sigma_\Psi}\right| \quad \text{and} \quad P = \frac{1}{\sqrt{2\pi}} \int_z^\infty e^{-0.5\varsigma^2} d\varsigma.$$

Since we did not specify a direction for a change in phase, the p-value for the block was given by:

$$p = 2 \times P,$$

and the two-tailed z-score was computed from the inverse normal distribution for P. In the experiment, the empirical value of P was used. That is, the number of Monte Carlo-derived RMS phases that were greater than or equal to the observed RMS phase was divided by the total number of Monte Carlo passes. Therefore, the 1-σ error estimate in P were computed from the binomial distribution for proportions. Or

$$\text{1-}\sigma \text{ error in P} = \sqrt{\frac{P\,(1-P)}{M}},$$

where M is the number of Monte Carlo passes.

For this replication, the analyst was "blind" to the identity of the receiver, the date, the experiment condition (i.e., experimental or control run), and the stimulus type.

2.1.9.2 Details of the Analysis

Consider N blocks of experimental data. Let n_{jr} be the number of remote stimuli r for block j, and n_{jp} be the number of pseudo stimuli p in block j. Similarly, define ε_{jr} and ε_{jp} as the corresponding effect sizes for block j. We define the weighted effect size for each stimulus type, k, as

$$\bar{\varepsilon}_k = \sum_{j=1}^{N} w_{jk}\varepsilon_{jk},$$

$$\bar{d} = \sum_{j=1}^{N} \Omega_j d_j.$$

The variance of $\bar{d}$ is given by:

$$Var(\bar{d}) = \sum_{j=1}^{N} \Omega_j^2 Var(d_j),$$

but

$$Var(d_j) = Var(\varepsilon_{jr}) + Var(\varepsilon_{jp}) - 2\ Cov(\varepsilon_{jr}, \varepsilon_{jp}),$$

but

$$Cov(\varepsilon_{jr}, \varepsilon_{jp}) = \varrho_{rp} \sqrt{Var(\varepsilon_{jr}) \cdot Var(\varepsilon_{jp})}.$$

Combining these equations with the definition for the variance of the effect size, gives the $Var(\bar{d})$ as

$$Var(\bar{d}) = \sum_{j=1}^{N} \Omega_j^2 \left[\frac{1}{n_{jr}} + \frac{1}{n_{jp}} - 2\ \varrho_{rp} \sqrt{Var(\varepsilon_{jr}) \cdot Var(\varepsilon_{jp})} \right],$$

and

$$Z = \frac{\bar{d}}{\sqrt{Var(\bar{d})}}. \tag{3}$$

Tests Against the Null Hypothesis: $\bar{\varepsilon}$(Experiment)$-\bar{\varepsilon}$(Control) = 0. To compare each stimulus type in the experimental and control conditions, we assume that the data are independent. Thus, the z-score for the difference is given by

$$Z_k(e - c) = \frac{\bar{d}}{\sqrt{Var(\bar{\varepsilon}_k(e)) + Var(\bar{\varepsilon}_k(c))}}$$

$$= \frac{\bar{d}}{\sqrt{\frac{1}{\sum_{j=1}^{N} n_{jk}(e)} + \frac{1}{\sum_{j=1}^{N} n_{jk}(c)}}}, \tag{4}$$

where e and c represent the experiment and after-block control conditions, respectively, d is the weighted difference for the stimulus type in the experiment and control conditions.

Equation 4 is used to test the difference between experimental blocks and their corresponding control blocks.

Rao relationship[19]). One representation of the Crammer-Rao relationship for the variance of the instantaneous phase, ϕ, is given by

$$Var(\phi) \geq \frac{1}{\Delta T \times R_{SN}},$$

where ΔT is the analysis time (i.e., 0.5 s in our case) and R_{SN} is the signal-to-noise ratio. For our typical brain-wave records, the lower bound for $Var(\phi)$ was approximately 2.67 rad,[2] or the expected error was 1.63 rad or 93.6 degrees. This estimate is a lower bound, but a more realistic estimate might be higher because of the nonstationary nature of brain-wave data. Thus, if there were phase shifts related to the RS, they likely would have been masked by the noise, and we would not have seen them.

Fortunately, we have saved all the raw data and are able to use an appropriate analysis to determine whether a phase shift occurred concomitant with the RS. We are unable to manipulate R_{SN}; however, we are able, in principle, to extend the analysis time, ΔT, arbitrarily. There are confounding factors that will limit the size of ΔT, so other techniques may have to be employed. In a recent article, Boashash has outlined a number of promising techniques that are specifically developed to address this problem in nonstationary data.[19]

It is important to look carefully at this data because a phase shift, or amplitude shift, should be there, given that the alpha rhythm appears to respond to a variety of non-AC tasks. One such example is event-related desynchronization (ERD). Spontaneous EEG reveals short-lasting, task- or event-related amplitude changes in rhythmic activity within the alpha band. This amplitude change, or desynchronization, is one of the elementary phenomena in EEG. It was first described in 1930 by Berger[20] in scalp EEG as alpha blocking, and was later termed ERD by Pfurtscheller and Aranibar.[21] ERDs can be quantified as a function of time and can then be used to study cortical activation patterns during the planning of motor behavior,[22] sensory stimulation, and cognitive processes.[23,24,25] Kaufman et al. provide a more recent example of cognitive-process-related ERDs.[26] They found a significantly shorter ERD when subjects simply responded to a target stimulus, compared with the ERD that occurred when a subject had to search visual memory to determine whether the target matched one previously presented.

If we take the historical behavioral AC data as evidence of an anomaly, it would be surprising not to find some form ERD, given we can provide the proper stimulus.

5. Suggested Research

Aside from the technical difficulties associated with the Crammer-Rao relationship, all of our earlier attempts to identify CNS correlates to AC did not contain any concomitant behavioral measure of AC; therefore, we have no independent measures that AC functioning occurred in these experiments. Also, the conditions under which experiments were conducted were not similar to those known to be conducive to the production of AC data. For example, there is no evidence that a flashing light constitutes a valid AC target. It is also likely that when a receiver is asked to recline face down in a MEG laboratory, that the conditions for the receiver are not optimal.

We suggest that new experiments be designed to measure CNS responses to AC stimuli. Since we will not be initially concerned about source localization, we will not immediately require the special properties of a MEG.

VII. ENHANCING DETECTION OF AC WITH BINARY ENCODING

This section comprises the final report for SOW item 6.2.3.3.

1. Objective

The objective of this pilot study was to use a two-by-five error correcting block code to improve the detection of AC.

2. Background

AC responses usually are narrative descriptions, which have been difficult to quantitatively assess. A number of analysis techniques have been developed to deal with this problem. In one of the earliest techniques, an analyst visited potential target sites and ranked them from best to worst match for each AC response. The analyst had to determine subjectively the boundaries of the target and the elements that were to be included in the analysis.[6]

During the next phase of the development, the target and the response were reduced to their individual conceptual attributes. The analyst then had to compare lists of discrete attributes; one defining the response and one each for the potential targets. This all-or-nothing binary determination proved to be inappropriate for an inherently imprecise situation.[27,28]

Fuzzy sets were then used to allow a gradation of judgment in defining specific elements of content within both the target and the response. This method, however, proved to be labor intensive and did not significantly improve the stability and reliability of AC analysis.[7]

This pilot experiment was designed to explore the potential for maximizing the reliability of AC responses through objective and rapid analysis. We have reverted to using a dichotomous binary procedure as opposed to a fuzzy set technique. By carefully selecting the dichotomous elements and by using standard block coding techniques to incorporate all single and a few double error corrections, the earlier problem of all-or-nothing binary determinism might be reduced. A message sending motif was used as a test-bed for this kind of analysis.

3. Approach

This pilot experiment was similar to a traditional AC experiment: a target was selected randomly; a receiver was asked to describe information that was not available to currently known sensorial channels; and a quantitative assessment of the match between the target and the AC response was made. It differs only in the construction of the target pool and in the quantitative analysis.

3.3 Receiver Selection

Five receivers were selected to participate in this experiment on the basis of their significant results from previous AC experiments.

3.4 Protocol

3.4.1 Number of Trials

The five receivers contributed eight trials each.

3.4.2 Trial Protocol

Before the experiment began each receiver was provided with instructions and a list of dates on which targets were to be at a prearranged location in the Menlo Park laboratory. The following steps were performed for each trial:

(1) The PI used a pseudo random number generator to select a photograph (i.e., a binary number) from the target pool and placed the photograph in a previously agreed upon location. This target remained in the designated location for one week for the convenience of the receiver. Receivers had access to the target, by AC methods only, at any point during this time period, since no senders or session monitors were involved in this study.

(2) Receivers were to find a quiet place in their homes to work with pen and paper. For a period lasting no longer than 15 minutes, each receiver was to write and draw his/her impressions of the target.

(3) The responses were sent by facsimile to the PI.

(4) The PI sent back a sheet of five questions about the target, which could be answered by "yes" or "no." These questions pertained to the five target attributes for the target pack from which the designated target was chosen (e.g., Does the target contain triangles?).

(5) The answers were sent back to the PI for analysis. Upon receipt, the PI provided a copy of the target photograph as feedback.

(6) This procedure was repeated until eight trials were obtained from each receiver.

3.4.3 Analysis

At the end of the experiment, the PI removed the name, date, and time from each response; randomized the order of the responses; and provided an analyst with the responses and associated target packs. The intended target was not disclosed. Three different methods of analysis were used in this experiment:

- Rank ordering
- Number decoding (analyst)
- Number decoding (receiver)

3.4.3.1 Rank-Ordering

Traditional rank-ordering was the first method of analysis. When a target was chosen from one of the target sets, the remaining three targets were considered "decoy" targets for an analyst. For each trial, an analyst was given the AC response and the target pack (i.e., four targets) from which the actual target was chosen. The analyst was required to rank order the targets within the designated pack from best to least match to the response, regardless of the quality of the matches. The rank that was assigned to the intended target represented the value of the dependent variable for the trial. A sum-of-ranks was then computed for all trials for each receiver. Effect sizes and p-values were determined from the known sum-of-ranks distribution. This method was used to determine the level of AC functioning for each

Table 11.

Statistics for the Sum-of-Ranks

Receiver ID	ΣR	$\bar{R}$	p-value	Effect Size
009	21	2.625	0.6797	−0.1118
083	25	3.125	0.9597	−0.5590
372	20	2.500	0.5617	0
389	19	2.375	0.4383	0.1118
454	18	2.250	0.3203	0.2236

In addition, the number of direct hits (i.e., first place ranks) were computed for each receiver and the binomial distribution was used to compute p-values and effect sizes from this perspective.

In Table 12, h is the number of first place ranks computed for each receiver.

Table 12.

Statistics for First Place Ranks

Receiver ID	h	p-value
009	1	0.900
083	0	1.000
372	2	0.633
389	1	0.900
454	2	0.633

4.2 Number Decoding

The number decoding method of analysis was used to test two hypotheses:

- A two-by-five, error correcting block code can be used to improve the detection of AC.
- Receivers who are asked to perform analytical tasks on their own data are not as accurate as an independent analyst.

The results of decoding by the receiver are shown in Table 13. The number of direct hits (i.e., event probability of 0.25) is shown as h. The p-value is computed from the exact binomial distribution.

chairs to an image of three geometric shapes, and thus possessed a large target-pool bandwidth. Since receivers were told in advance that the targets could contain absolutely any material, they were unable to censor their internal experiences, which may have resulted in enhanced intrinsic receiver noise (see Section IV.5.3).

- Each encoding bit was linked to only one percept (e.g., the single target element of water). This exaggerated the importance of the chosen dichotomous elements. For example, if a receiver failed to sense water in the target but managed to sense most other aspects of the target that were not part of the bit structure, then the block coding was not particularly applicable.
- In an AC application, a fundamental imbalance exists in the bit structure. The block coding assumes that binary zero is "assertive." That is, in AC when *water* is not indicated in the response, it is equivalent to indicating the *water* is definitely not in the target. In AC experiments, however, unless a receiver specifies explicitly that *water* is not present, then the presence or absence is indeterminate. Maybe water exists in the target but was not noticed or was unreported by the receiver. Similarly, *water* may not exist in the target and a non-response is equivalent to an assertive no. These two cases are, of course, indistinguishable. The net effect is to render the block coding invalid.

Because of these difficulties, we recommend that the experiment be repeated with the following improvements:

- Reduce the target-pool bandwidth by using the *National Geographic* static target pool, which has been successful for many AC experiments.
- Reduce the sensitivity to single block encoding bits by incorporating a number of fuzzy-set elements for each bit. Thus, each bit will not rely upon a single percept, but rather represent classes of different percepts.

We anticipate that these improvements will allow for much stronger AC, and provide a more sensitive test of whether binary error-correcting can be successfully applied to AC detection.

VIII. SUBCONTRACTS

Under this current effort we let three subcontracts to address specific items in the SOW.

1. Edinburgh University

This section constitutes part of the final report for SOW item 6.2.3.2.

We subcontracted to the Psychology Department of Edinburgh University to construct an isolation room, which was designed specifically for Ganzfeld studies. The room is now complete and pilot Ganzfeld trials are being conducted.

As part of their statement of work, we specified that the sound attenuation characteristics of the Ganzfeld isolation room must be measured. The Department of Building Engineering and Surveying of Heriot-Watt University was asked to conduct the appropriate measurements.

We find that the room is sufficiently physically isolated from the sender's location and the sound attenuations is reasonable for Ganzfeld studies.

2. Psychophysical Research Laboratories (PRL)

This section constitutes the final report for SOW item 6.2.2.4, the remainder of item 6.2.3.2, and item 6.3.2.2.

To assist in our ongoing effort to determine what variables might be important in AC experiments, we subcontracted with Mr. Charles Honorton, the director of PRL, to improve an earlier meta-analysis of the literature pertaining to characteristics of persons who might perform well in AC tasks. Specifically, he found that good novice Ganzfeld performers reported personal experience with natural AC, participated in earlier AMP experiments, were involved with mental disciplines such as meditation, and tended toward the Intuition side of the Sensing/Intuition scale of Myers-Briggs Type Indicator. Honorton's complete report can be found in Appendix B.

As part of our effort to understand the role of the sender in AC experiments, we asked Mr. Honorton to conduct a meta-analysis of the Ganzfeld literature to determine if there were meaningful differences between Ganzfeld studies with and without a sender. Unfortunately, there were insufficient numbers of Ganzfeld experiments conducted in the clairvoyant mode (i.e., without a sender) to be able to ascertain, from the published literature, the sender's role. Appendix C contains Mr. Honorton's detailed meta-analysis of the available literature.

Because the results of the meta-analysis proved to be inconclusive, PRL was tasked to design a protocol for a definitive Ganzfeld study to understand the role of the sender in such experiments. That protocol, detailed in Appendix D, superimposes on the standard auto-Ganzfeld procedure an additional 4-state sender condition. That is, the sender is either:

IX. OTHER ACTIVITY

1. Correlations between AC and Geomagnetic Activity

This section comprises the final report for SOW item 6.2.2.3.

1.1 Background

Persinger, Tart, Krippner, and others have reported an association between AC performance and indices of geomagnetic field (GMF) fluctuations. This work has shown that both anecdotal reports of spontaneous AC, as well as higher-scoring laboratory AC trials, tend to occur at times of relatively low GMF activity. The published evidence is not entirely compelling. The anecdotal AC data are contaminated to an unknown extent with confounding factors of reporting bias, timing errors, and the difficulty of establishing the veracity of such reports *post hoc*. The retrospective studies of laboratory AC data, while largely free of these problems, have demonstrated only small correlations to GMF indices. There is, however, increasing interest in the possibility of biological effects of small amplitude magnetic field variations. Recent work has shown that melatonin and serotinin levels are modulated by GMF activity both in vivo and in vitro. Other research is exploring the physics of possible mechanisms whereby low-amplitude magnetic field variations could interact with cells.

1.2 Anomalous Cognition

To investigate the relationship between scores in laboratory AC experiments and GMF fluctuations, we are combining various experimental databases. Currently, we have assembled a database of approximately 1,000 free-response AC trials from several laboratories. There is a very small (i.e., $\varrho = -0.05$, $p \leq 0.09$) correlation between trial scores and GMF fluctuations in the expected direction in this database. The correlation, however, is much larger (i.e., $\varrho = -0.40$) in those experiments where significant AC was demonstrated.

1.3 Epilepsy

We may discover more about the impact of GMF fluctuations on AC performance by research on other behaviors that are modulated by very low frequency magnetic fields. Some literature suggests a connection between idopathic and epileptic seizures and GMF fluctuations. Currently, we have assembled a database of approximately 4,000 seizures and seizure-related mortalities. Preliminary analysis of a subset of this database suggests that both seizures and mortalities associated with seizures are weakly correlated with elevated GMF noise levels. GMF noise might be depressing the melatonin level, resulting in an increased probability of seizure. We have submitted a paper, which describes the results of the GMF/epilepsy investigation, for publication in the British medical journal, *The Lancet*. This paper may be found in Appendix F.

found that dreaming is similar to the waking state. Motor action is mostly inhibited from the brain stem downward; however, the cerebral cortex appears not to "know" this.

In this preliminary pilot study, we used the skills developed by LaBerge to teach individuals to lucid dream. Differing from the earlier AC dream studies, our dreamers were instructed to adopt a proactive attitude to seek out and remember the AC target. In this way, we tried to determine the degree to which lucid dreaming can facilitate the reception of AC material.

3.3 Approach

3.3.1 Receiver Selection

We used two specialized populations from which we drew receivers for this pilot experiment:

(1) Experienced dreamers from LaBerg's research subjects (three receivers)

(2) Receivers who have demonstrated significant ability in other AC studies (four receivers)

3.3.2 Target Selection

Targets were chosen randomly from the standard set of 100 *National Geographic* magazine photographs.

3.3.3 Trial Definition

A trial was defined as a successful lucid dream during which the target material was examined and later transcribed in the waking state.

3.3.4 Lucid Dream Protocol

All receivers undertook two forms of training in lucid dreaming: (1) They completed a lucid dreaming home-study course developed by the Lucidity Institute, and (2) they attended two weekend seminars, one at the beginning and one at the end of a three-month pilot study. The first seminar, which was held in December, 1991, introduced receivers to lucid dreaming skills and the use of the DreamLight™, a lucid dream induction device. In previous studies, the DreamLight™ has been shown to enhance the frequency of lucid dreaming. The DreamLight™ consists of a sleep mask equipped with lights and eye movement sensors, which are attached to a small battery-operated computer. When the computer detects the eye movements of dreaming (i.e., REM) sleep, it causes the lights in the mask to flash briefly (i.e., either one or two flashes per second). The dreamer frequently incorporates the flashes into the ongoing dream, and thus experiences a cue to indicate that he or she is dreaming. Receivers had access to DreamLights™ during the duration of the study.

3.3.5 AC Baseline Measures

The three inexperienced receivers from the Lucidity Institute were asked to contribute eight AC trials in a waking state in the Cognitive Sciences Laboratory as an AC baseline series. The targets for these series were chosen at random from the standardized target set. Each trial was conducted as follows: After the receiver and a monitor entered the AC laboratory (i.e., an office with a single desk and two chairs), an assistant used a computer random number generator to select a target from the baseline target pool. Both the receiver and the monitor were blind to this specific choice. At a pre-arranged time, the monitor encouraged the receiver to draw and write impressions of the target material, which was located approximately 30 m away. After approximately 15 minutes of casual questioning, the trial ended; the data were copied; the originals were secured; and the actual target was presented as feedback to the receiver.

Physical Interpretation of Potentials. Classical mechanics and, for the most part, quantum mechanics have treated potentials as convenient mathematical descriptions for which there are no physical counterpart. Recent experiments have shown, however, that a potential can affect a particle even when there is no corresponding force present. If potentials could be made to propagate, then they could be candidates for an energy transfer mechanism for AC.

3. Anomalous Perturbation

This section constitutes the final report on SOW item 6.2.5.

At the sponsor's request, we provided two receivers to participate in an informal and exploratory anomalous perturbation experiment. The target system was a special E&M wave device; there was no particular protocol; and we report, in the form of a laboratory anecdote, that a sufficiently large number of unexpected events occurred to suggest that additional and more formal data must be collected.

4. Fuzzy Set Analysis

This section constitutes the final report on SOW item 6.3.2.1.

4.1 Background

The elements in our fuzzy set representation of our target pool are structured in *levels*, ranging from the relatively abstract, information poor (such as vertical lines—level 1), to the relatively complex, information rich (such as churches—level 10). The current system is structured into seven primary and three secondary levels of descriptors; the main intent of this structure is to serve as a heuristic device for guiding the analyst into making judicious concrete descriptor assignments based on rather abstract commentary. The determination as to which descriptors belonged on which level was made after consideration of two primary factors: (1) the apparent ability of receivers' to resolve certain features, coupled with (2) the amount of pure information thought to be contained in any given descriptor. Some of these "factor one" determinations were based on observations of analysts and monitors in the course of either analyzing or conducting numerous AC experiments and on subjective lore; some were determined empirically from *post hoc* analyses of receivers' abilities to perceive various descriptor elements in previous experiments.

The "factor two" determinations were made primarily by arranging the descriptors such that a descriptor at any given level represents the sum of constituent descriptors at lower levels. The world is not a very crisp place and not all of its elements are amenable to hierarchical structuring. Certain violations of the "factor two" rule appear, therefore, throughout the proposed levels. Some of the more glaring violations were largely driven by the "factor one" determinations (i.e., the receivers' abilities to discern certain elements) enumerated above.

Thus, the visual information content as described by our fuzzy-set encoding ranges from the specific and detailed for level 10 to the unspecific and abstract for level 1. Please see Appendix A for a complete list of fuzzy set elements and their associated levels.

4.2 Analysis

Using the data from the static target set in the target-dependency experiment (see Section IV), we correlated the *post hoc* scores and the blind ranks with the content in each of the fuzzy set levels. Figure 19

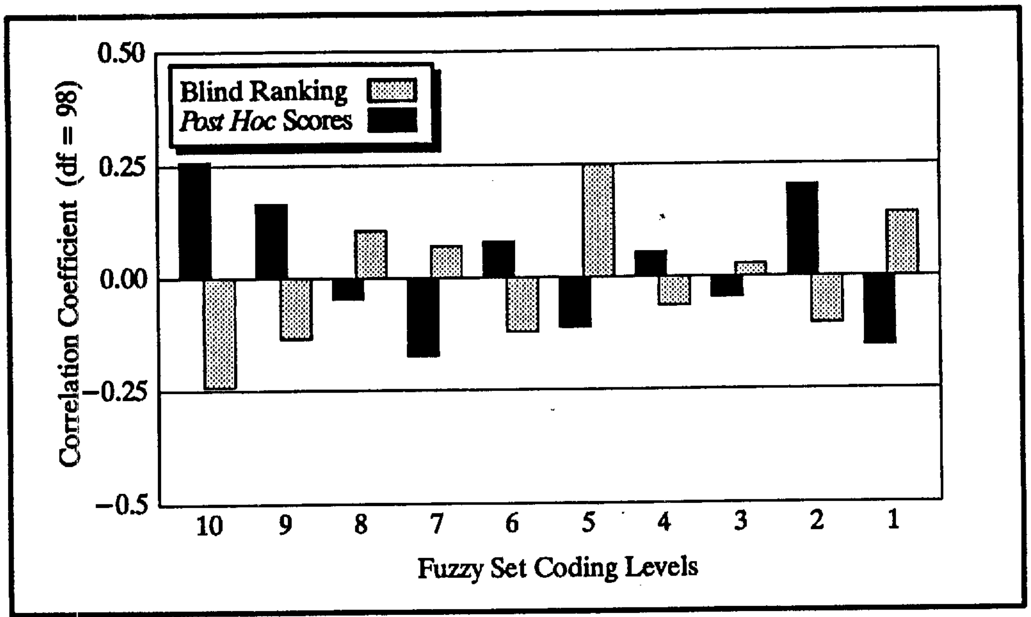


Figure 20. Correlation: Levels of Visual Complexity with *Post Hoc* Ratings and Blind Rankings for all *Post Hoc* Scores

4.3 Conclusion

Generally, elements that assist in a *post hoc* analysis are not the same elements that assist in blind ranking. Fuzzy set elements, which are generally image specific, are most sensitive in blind rank analysis, but specific visual elements are best for *post hoc*. These conclusions are based upon on set of 100 AC trials. It is currently unknown the degree to which they will generalize.

5. Empirical Training Overview

This section constitutes the final report on SOW item 6.3.3.1. The following discussion has been primarily provided by Professor D. Bem of the Psychology department of Cornell University.

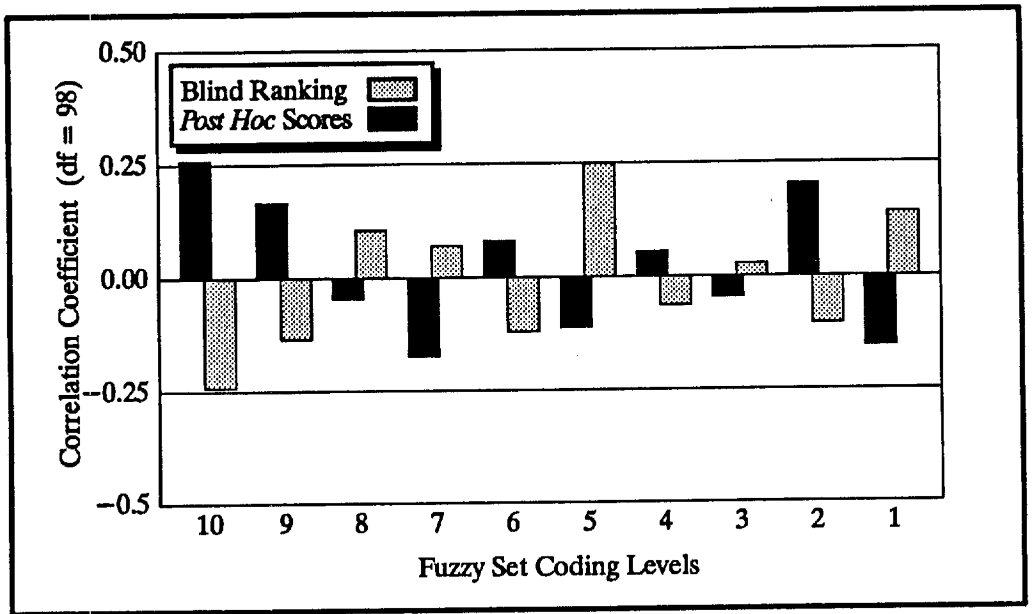
5.1 Overview

We have examined a stimulus-response training method, which has been in use for a number of years.[42] Generally, this method assumes that internal visual imagery is a strong source of noise, at least for beginning receivers. The training method is highly focused on the structure of the response as an attempt to limit imagery. Not unlike a word association test, a receiver is asked to respond, as quickly as possible, to a stimulus such as the word "target." By refraining from a long introspection time, it is hoped that internal imagery does not have time to interfere with the AC "signal."

The training method requires that the structure of the response change as a student advances through a series of discrete stages. The stages represent access to increasing information about the target material. For example, Stage I consists primarily of large scale generalities about a site, such as mountains and cities, whereas Stage VI consists of specific analytic details involving relationships among the response elements.

5.2 Analysis

Most of the concepts outlined in this training method have not been individually tested under laboratory conditions. The method, however, has been used "successfully" in that individuals who have been trained by



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explicitly told that it is not considered undesirable to pass, but it simply reflects a stylistic preference for ways of communicating.

(2) The receiver now generates any adjectives or terms that occur spontaneously. Passes are also allowed.

(3) The receiver is now prompted with a set of Semantic Differential Scales—bipolar dimensions—and asked to respond verbally in a stimulus-response fashion. For example, the trainer might say "hot-cold" and the viewer might respond with "warm, cold, stiff, sauna, or pass." In other words, the trainer gives the dimension and the receiver gives any response at all.

(4) The receiver may now supply any additional dimension and/or terms that occur to him or her. This is essentially a repeat of step 1, recognizing that step 3 may have promoted new material.

(5) The session ends after a number of repeats of steps 1-4 and with a final integration of drawn and verbal material.

5.4 Discussion

Note that this sequence goes from unstructured to structured responses, with no pressure to use any procedure that seems uncomfortable. For example, if the receiver feels distracted by having to use pen and paper, he or she should have the option not to do so; the monitor could tape-record the session, for example.

Step 3 is modeled on word association techniques. There are several possibilities for the scales. We could:

- Use our visual fuzzy set elements.
- Select dimensions from previous work on the Semantic Differential.
- Conduct a preliminary study on a subset of targets that are displayed to receivers, and allow the receivers to generate dimensions that are tailored specifically by them for those targets.
- Let each receiver construct his or her own impressionistic vocabulary by serving in a session described above. Then present these individualized dimensions as stimuli in the subsequent AC sessions.

The dimension of the presented stimuli should not be confined to physical/visual features of targets but should range widely over affective and impressionistic dimensions as well (e.g., *kind-cruel, soft-hard, good-bad*). The Semantic Differential was originally developed to tap *affective* or *connotative* meaning, and factor analyses uncovered three orthoginal dimensions that appear to have cross-cultural universality:

(1) An evaluative dimension (e.g., *good-bad*)

(2) An activity dimension (e.g., *active-passive*)

(3) A potency dimension (e.g., *strong-weak*)

An effective procedure should use scales from all three factors.

It is possible to use prompts other than those of bipolar dimension. For example,the prompt could be the name of a sensory modality like *smell* or *odor* to which a receiver could respond "dank, bakery, acidic, or pass." Or the prompt could be *mood* or *emotion* and the response could be "sad, tranquil, agitated, or pass." Cross-cultural research reveals that six dimensions of affect appear to be universal: happy, sad, anger, fear, disgust, and surprise. These might be pertinent for some target pools.

We have stressed cross-cultural dimensions here to approach AC from the viewpoint of evolution. If some kind of AC is functionally adaptive for the species, what would its properties be? Affectively relevant information is the most likely to be accessed in AC-related ways, and universal categories of affective description have the best chance for transducing such information. In contrast, we speculate that

with blindsight can make visual discriminations, for example, of form and color, without perceiving the form or color of the stimuli. Blindsight, then, is a compelling example of preconscious, or perhaps extra-conscious processing.

Other evidence of preconscious processing can be found by comparing the sensory and perceptual thresholds. The sensory threshold can be determined physiologically by measuring the amplitude of a stimulus that elicits an identifiable signal in a receptor system, for example, a change in the firing rate of a sensory neuron. The perceptual threshold can be defined as that amplitude of the same stimulus that elicits a response indicating that the stimulus has been detected. It is a well-known phenomenon that the sensory and perceptual threshold can differ markedly.[46,47] Thus, between the sensory and perceptual thresholds, the receiver is processing information that is below the perceptual threshold, that is, preconscious processing.

The question of interest here is whether the perceptual threshold can be reduced so that it is closer to the physiological threshold. Several studies suggest conditions under which the perceptual threshold can be lowered to more closely approximate the sensory threshold. For example, changing the emotional content of the stimuli or the emotional state of the receiver has been shown to affect the perceptual thresholds for subliminal stimuli.[48,49] Essentially, reducing the emotional state of the receiver or elevating the emotional content of the stimulus reduces the perceptual threshold.

The question can now be refined to ask whether the perceptual threshold can be reduced through training. Couched in terms of signal detection theory, the question can be posed: Can the receiver's threshold be changed through training so that the receiver can detect a signal at a lower signal-to-noise ratio?

Here, again, the answer is yes. Detection thresholds have been found to respond to training protocols that use feedback on repeated trials to elevate sensitivity to previously unperceived visual cues.[50,51,52] We suggest that the detection threshold be changed through a program of repeated feedback.

6.2 A Suggested Experiment

This suggested experiment has a two-fold purpose. The first is to assess the effects of training protocols on the detection thresholds for subliminal visual stimuli. The second is to examine whether those receivers whose thresholds were lowered by training perform better on AC tasks than receivers who have not been through the training. By using threshold-lowering training protocols, we will attempt to increase the sensitivity of receivers to subliminal visual stimuli so that following training, stimuli that had been subliminal will be supraliminal. We will then determine whether there is a parallel increase in sensitivity to AC stimuli.

Specifically, we suggest that receivers first be randomly assigned to a subliminal-training group and a sham-training group. No receiver will be informed of his or her status until both the training and remote-viewing portions of the study have been completed.

Each receiver in both groups will be shown a series of target images that are presented tachistoscopically for approximately 10 milliseconds, alternating with a 5-second presentation of a masking stimulus. All target images will be below the receiver's detection threshold, that is, they will be subliminal. Interspersed randomly among the subliminal stimuli will be an equal number of blank trials in which no target image is presented during the 10-millisecond presentation.

X. GLOSSARY

Not all the terms defined below are germane to this report, but they are included here for completeness. In a typical anomalous mental phenomena (AMP) task, we define:

- Anomalous Cognition (AC)—A form of information transfer in which all known sensorial stimuli are absent.
- Agent—An individual who attempts to influence a target system.
- Analyst—An individual who provides a quantitative measure of AC.
- Anomalous Perturbation (AP)—A form of interaction with matter in which all known physical mechanisms are absent.
- Feedback—After a response has been secured, information about the intended target is displayed to the receiver.
- Monitor—An individual who monitors an AC session to facilitate data collection.
- Protocol—A template for conducting a structured data collection session.
- Receiver—An individual who attempts to perceive and report information about a target.
- Response—Material that is produced during an AC session in response to the intended target.
- Sender/Beacon—An individual who, while receiving direct sensorial stimuli from an intended target, acts as a putative transmitter to the receiver.
- Session—A time period during which AC data are collected.
- Specialty—A given receiver's ability to be particularly successful with a given class of targets (e.g., people as opposed to buildings).
- Target—An item that is the focus of an AMP task (e.g., person, place, thing, event).
- Target Designation—A method by which a specific target, against the backdrop of all other possible targets, is identified to the receiver (e.g., geographical coordinates).

REFERENCES

1. D. L. Delanoy, "Characteristics of Successful Free-Response Targets: Experimental Findings and Observations," Proceedings of Presented Papers of the Parapsychological Association 31st Annual Convention, pp. 230-246, Montreal, Canada (August 1988).
2. C. Watt, "Characteristics of Successful Free-Response Targets: Theoretical Considerations," Proceedings of Presented Papers of the Parapsychological Association 31st Annual Convention, pp. 247-263, Montreal, Canada (August 1988).
3. C. Honorton, R. E. Berger, M. P. Varvoglis, M. Quant, P. Derr, E. I. Schechter, and D. C. Ferrari, "PSI Communication in the Ganzfeld," *Journal of Parapsychology,* Vol. 54, pp. 99-139 (June 1990).
4. C. Honorton and D. C. Ferrari, "'Future Telling:' A Meta-analysis of Forced-choice Precognition Experiments, 1935-1987," *Journal of Parapsychology,* Vol. 53, pp. 282-308 (December 1989).
5. C. Honorton, "Error Some Place!" *Journal of Communication*, pp. 103-116, (Winter, 1975).
6. H. E. Puthoff and R. Targ, "A Perceptual Channel for Information Transfer over Kilometer Distances: Historical Perspective and Recent Research," *Proceedings of the IEEE,* Vol. 64, No. 3, pp. 329-354, (March, 1976).
7. E. C. May, J. M. Utts, B. S. Humphrey, W. L. W. Luke, T. J. Frivold, and V. V. Trask, "Advances in Remote-Viewing Analysis," *Journal of Parapsychology,* Vol. 54, pp. 194-228, (September, 1990).
8. E. C. May and Wanda L. W. Luke, "Phenomenological Research and Analysis," SAIC Interim Report Covering 2/91–12/91, SAIC Project 01-187-07-406, Menlo Park, CA (February 1992).
9. H. E. Puthoff, "Calculator-Assisted PSI Amplifaction," *Research in Parapsychology 1984,* pp. 48-54 (1984).
10. M. Ryzl, "A Model of Parapsychological Communication," *Journal of Parapsychology,* Vol. 30, pp. 18-30, (1966).
11. H. E. Puthoff, E. C. May, and M. J. Thomson, "Calculator-Assisted PIE Amplification II: Use of the Sequential-Sampling technique as a Variable-Length Majority-Vote Code," *Research in Parapsychology 1985,* pp. 73-77 (1985).
12. E. C. May, B. S. Humphrey, and G. S. Hubbard, "Electronic System Perturbation Techniques," Project 8585, SRI International, Menlo Park, CA, (October 1980).
13. D. I. Radin and E. C. May, "Testing the Intuitive Data Soriing Model with Pseudorandom Number Generators: A Proposed Method," *Proceedings of the 29th Annual Convention of the Parapsychology Association,* pp. 537-554 (August 1986).
14. T. G. Lewis and W. H. Payne, "Generalized Feedback Shift Register Pseudorandom Number Algorithm," *Journal of the Association for Computing Machinery,* Vol. 20, No. 3, pp. 456-468 (July 1973).
15. C. S. Rebert and A. Turner, "EEG Spectrum Analysis Techniques Applied to the Problem of Psi Phenomena," *Physician's Drug Manual,* Vol. 4., Nos. 1-8, pp. 82-88 (1974).
16. R. Targ, E. C. May, H. E. Puthoff, D. Galin, and R. Ornstein, "Sensing of Remote EM Sources (Physiological Correlates)," Final Report, Project 4540, SRI International, Menlo Park, CA (1977).

35. R. G. Jahn and B. J. Dunne, *Margins of Reality: The Role of Consciousness in the Physical World*, Harcourt Brace Jovanovich, Orlando, FL (1987).

36. R. G. Stanford, "An Experimentally Testable Model for Spontaneous PSI Events," *Journal of the American Society for Psychical Research*, Vol, 68, pp. 34-57 (1974).

37. E. C. May, "Intuitive Data Sorting: An Informational Model of Psychoenergetic Functioning," Final Report—Objective E, Tasks 3 and 4, Project 1291, SRI International, Menlo Park, CA (December 1986).

38. S. W. Hawking, *A Brief History of Time: From the BIg Bang to Black Holes*, Bantam Books, New York, NY (1988).

39. E. C. May and W. L. W. Luke, "Phenomenological Research and Analysis," Final Technical Report, Project 1-187-07-406-10, SAIC, Menlo Park, CA (1992).

40. C. Honorton and D. C. Ferrari, "'Future Telling:' A Meta-analysis of Forced-choice Precognition Experiments, 1935-1987," *Journal of Parapsychology*, Vol. 53, pp. 282-308 (December 1989).

41. M. Visser, "Traversable Wormholes: Some Simple Examples," *Physical Review D*, Vol. 39, No. 10, pp. 3182-3184 (May 1989).

42. I. Swann, "Coordinate Remote Viewing," SRI Internationa, Menlo Park, CA (1985).

43. R. Rosenthal and D. B. Rubin, "Summarizing 345 Studies of Interpersonal Expectancy Effects," *New Directions for Methodology of Social and Behavioral Sciences: Quantitative Assessment of Research Domains*, pp. 79-95, Jossey-Bass, San Francisco (1980).

44. O. Poetzl, "The relationship between experimentally induced dream images and indirect vision," Monograph No. 7, *Psychological Issues*, Vol. 2, pp. 41-120 (1917).

45. L. Weisdrantz, *Blindsight: A Case Study and Implications*, Clarendon Press, Oxford (1986).

46. E. Gellhorn "Physiological processes related to consciousness and perception," *Brain*, Vol. 77, pp. 401-415 (1954).

47. B. Libet, W. W. Alberts, E. W. Wright, and B. Feinstein, "Responses of the human somatosensory cortex to stimuli below the threshold for conscious sensation," *Science*, Vol. 158, pp. 1597-1600 (1967).

48. N. F. Dixon and T. E. Lear "Perceptual regulation and mental disorder," *Journal of Mental Science*, Vol. 108, pp. 356-361 (1962).

49. P. Tyrer, P. Lewis, and I. Lee, "Effects of subliminal and supraliminal stress on symptoms of anxiety," *Journal of Nervous and Mental Disorders*, Vol. 166, pp. 611-622 (1978).

50. B. Bridgeman and D. Staggs "Plasticity in human blindsight," *Vision Research*, Vol. 22, pp. 1199-1203 (1982).

51. J. Zihl, "Blindsight: Improvement in visually guided eye movements by systematic practice in patients with cerebral blindness," *Neuropsychobiologica*, Vol. 18, pp. 71-77 (1980).

52. J. Zihl, and R. Werth, "Contributions to the study of 'blindsight' – II. The role of specific practice for saccadic localization in patients with postgeniculate field defects," *Neuropsychobiologica*, Vol. 22, pp. 13-22 (1984).

APPENDIX A

Target Elements for the Fuzzy Set Representation of AC Targets

Fuzzy Set Attributes and Levels

Attribute	Description	Level
1	Fort	10
2	Castle	10
3	Palace	10
4	Church, Religious	10
5	Mosque	10
6	Pagoda	10
7	Coliseum, Stadium, Arena	10
8	Bridge	9
9	Dam, Lock, Spillway	9
10	Boats, Barges	9
11	Pier, Jetty	9
12	Motorized Vehicles	9
13	Column	9
14	Spire, Minaret, Tower	9
15	Fountain	9
16	Fence	9
17	Arch	9
18	Wall	9
19	Monument	9
20	Roads	8
21	Port, Harbor	7
22	Oasis	7
23	Agricultural Fields	7
24	Industrial	7
25	Recreational	7
26	Religious	7
27	Mechanical	7
28	Technical	7
29	Agricultural	7
30	Commercial	7
31	Wilderness	7
32	Urban	7
33	Rural, Pastoral	7
131	Historical/Archaeological	7
34	Ruins, Incomplete Buildings	6

Fuzzy Set Attributes and Levels (continued)

Attribute	Description	Level
70	Grey	4
71	Shiny, Reflective	4
72	Gold	4
73	Silver	4
74	Chrome	4
75	Copper	4
76	Obscured, Fuzzy, Dim, Smoky	4
77	Cloudy, Foggy, Misty	4
78	Old	4
79	Weathered, Eroded, Incomplete	4
80	Smooth	4
81	Fuzzy	4
82	Grainy, Sandy, Crumbly	4
83	Rocky, Ragged, Rubbled, Rough	4
84	Striated	4
85	Hot	4
86	Cold, Snow, Ice	4
87	Humid	4
88	Dry, Arid	4
89	Flowing	4
90	Other Implied Movement	4
91	Congested, Cluttered, Busy	4
92	Serene, Peaceful, Unhurried	4
93	Closed In, Claustrophobic	4
94	Open, Spacious, Vast	4
95	Ordered, aligned	4
96	Disordered, Jumbled, Unaligned	4
97	Buildings, Structures	3
98	Rise, Vertical Rise, Slope	3
99	Flat	3
100	Light/Dark Areas	3
101	Boundaries	3
102	Land/Water Interface	3
103	Land/Sky Interface	3
104	Single Predominant Feature	3

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APPENDIX B

The Ganzfeld Novice: Four Predictors of Initial ESP Performance

The Ganzfeld Novice: Four Predictors of Initial ESP Performance

Charles Honorton
University of Edinburgh

Abstract: This report updates earlier studies examining characteristics of successful novice ganzfeld participants. A new study comprising Novice Series 103-105 in the PRL automated ganzfeld study (Honorton, Berger, Varvoglis, Quant, Derr, Schechter, & Ferrari, 1990) is compared with a previous PRL study (Honorton & Schechter, 1987) and an independent study reported by the FRNM research team (Broughton, Kanthamani, & Khilji, in press). ESP ganzfeld performance is examined in relation to four predictors: reported personal psi experiences, Myers-Briggs Feeling/Perception, prior (nonganzfeld) psi testing, and involvement with mental disciplines such as meditiation.

One of the goals of the PRL automated ganzfeld research was to identify characteristics associated with successful ESP ganzfeld performance by previously inexperienced participants (novices). Two hundred and six participants each contributed to one of five novice series in the PRL automated ganzfeld project. (See Honorton, Berger, Varvoglis, Quant, Derr, Schechter, & Ferrari [1990] for details of experimental procedures and overall results.) Most participants completed Form F of the Myers-Briggs Type Indicator (MBTI; Briggs & Myers, 1957) and a 55-item demographic survey (Participant Information Form, PIF).

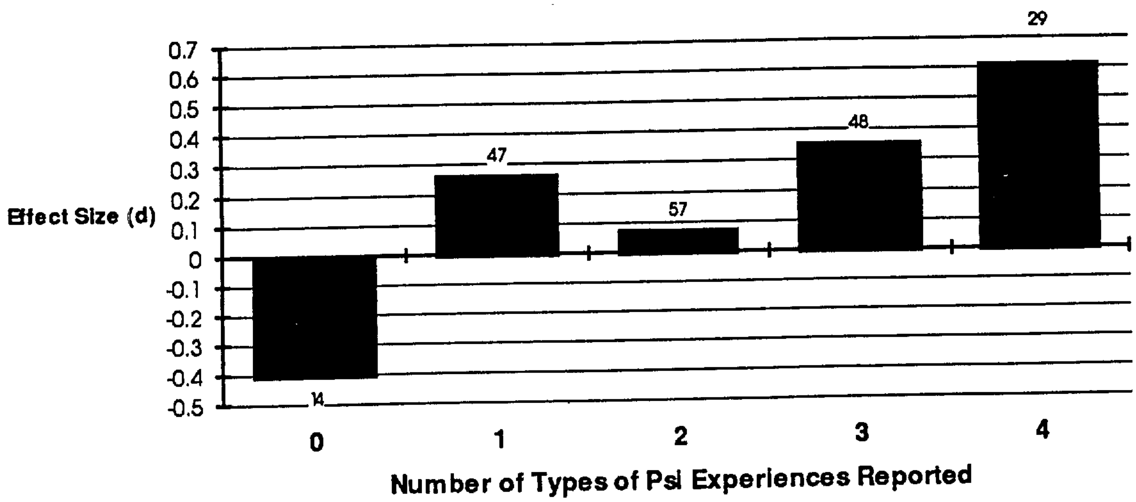
Three previous reports have already described aspects of the PRL-novice research. The relationship between novice ESP ganzfeld performance and extraversion was presented by Honorton, Ferrari, & Bem (in press). Schlitz & Honorton (1992) described a subset of the PRL novice data involving performing artists from The Juilliard School. At the 1986 PA Convention, Honorton and Schechter (1987) presented an exploratory analysis of performance correlates for the first two PRL novice series (Series 101-102; hereafter designated PRL-1), suggesting that initial ganzfeld ESP performance was positively and significantly related to self-reports of personal psi experiences, Feeling/Perception (FP) preferences on the MBTI, and prior participation in nonganzfeld psi experiments. A positive but nonsignificant tendency for better performance among participants reporting involvement with mental disciplines such as meditation was also found.

Broughton, Kanthamani, & Khilji (in press) successfully replicated the ESP/FP finding in an independent study at FRNM. In this paper, the PRL-1 findings will be compared with those in the later PRL novices series (Series 103-105; hereafter designated PRL-2) and the FRNM series to estimate the overall magnitude and consistency of the four predictors.

Following presentation of the Honorton & Schechter report, an effort was made to obtain Myers-Briggs data from PRL-1 participants who had not originally taken the MBTI, and ten participants kindly cooperated. Their data are included in the PRL-1 totals in this report. The PRL-1 findings summarized in this paper also reflect corrections for a number of data entry errors in the Honorton & Schechter (1987) report that were discovered during a data audit of the entire PRL automated ganzfeld database prior to publication of Honorton, et al., (1990).

The PRL novices included 121 women and 85 men (total N = 206). PIF data was available for 195 and MBTI data was available for 190 subjects. As can be seen from Table 1, these participants

Figure 1. Ganzfeld Performance in Relation to Reported Psi Experiences



0.75, h = .08, 95% CI from 21% to 36%). The three studies combined yield a success rate of 31% (N = 326, p = .012, z = 2.25, h = .13, 95% CI from 26% to 36%). The effect sizes of the three studies are quite consistent (χ^2 = 2.39, 2 df, p = .30).

Reported Personal Psi Experiences

Following standard definitions of the four basic psi types, PIF item 14 asks "If you have had experiences which you thought involved psi, which of the following do you feel you have experienced (please check)." One point was given for each of the checked items (telepathy, clairvoyance, precognition, psychokinesis) and their sum constituted the psi experiences predictor.

Honorton and Schechter (1987) found a significant positive correlation between the number of types of psi experiences and psi ganzfeld

Table 3. Ganzfeld Psi Performance in Relation to An Alternate Measure of Reported Psi Experiences

Personal Psi Experiences?	Study	*N* Trials	% Hits	95% CI From	95% CI To	Effect Size (*h*)	*z*	*p*
"None"	PRL-1	7	14	1	55	-.27	-1.11	.867
	PRL-2	7	29	5	66	.08	-0.14	.555
	FRNM	17	29	12	54	.10	0.19	.426
	Combined	31	26	11	41	.01	-0.28	.61
"Some"	PRL-1	84	33	24	43	.18	1.61	.054
	PRL-2	97	36	27	45	.24	2.33	.010
	FRNM	91	31	22	40	.13	1.14	.126
	Combined	272	33	28	39	.19	2.96	.0015
Difference in proportions ("None" vs. "Some")							0.85	.197

Table notes. Percent hits and confidence estimates are rounded to nearest percentage point. Combined effect sizes and Stouffer's zs are weighted by study sample sizes. Confidence intervals for subsets with $N \leq 30$ are based on Blyth & Still (1983). None/Some difference is based on a z-test for binomial proportions using the combined (sample size weighted) estimates for each group.

them had not been previously involved in formal psi research of any kind, approximately 16% of the PRL novices and 13% of FRNM novices had participated in other types of psi research. In PRL-1 a hit rate of 50% was achieved by novices who had previously participated in other, nonganzfeld, psi experiments (N = 20, p = .014, z = 2.20, h = .52), while only 26% of those with no prior psi testing experience had hits (N = 72, 19 hits and 53 misses, p = .437, z = 0.16, h = .03). The distribution of hits and misses in relation to prior testing was significant: Overall-adjusted Fisher exact test (p = .024, *phi* = .21). In PRL-2, 67% of those with previous testing experience had hits (N = 12, p = .0028, z = 2.77, h = .86) as did 32% of subjects with no prior testing history (N = 92, p = .095, z = 1.31, h = .15). The Overall-adjusted Fisher test of the distribution of hits and misses was significant (p = .02, *phi* = .23).

This effect was not replicated in the FRNM study, which showed a slight reversal of the trend: hits were obtained by 29% of subjects with prior testing (N = 14, p = .479, z = 1.05, h = .08) and by 31% of those with no prior testing (N = 94, p = .118, z = 1.18, h = .13); Overall-adjusted Fisher p = .543 (*phi* = -.01). The overall effect of prior testing is significant, though clearly further research will be needed to assess the cross-laboratory generality of this finding. (See Table 4.) The mean weighted *phi* is .14 (95% CI from .02 to .25).

Myers-Briggs Feeling-Perception

Following MBTI convention, participants were classified as FP if their continuous scores on the TF and JP Scales were both above 100. A recent reevaluation of the MBTI in terms of the five-factor model of personality (McCrae & Costa, 1989) indicates that the MBTI TF Scale correlates positively with Agreeableness. JP correlates negatively with Conscientiousness (i.e., orderliness) and positively with Openness to Experience.

In PRL-1, 50% of the MBTI FP participants obtained hits (p = .00057, z = 3.25, h = .52) compared to 18% of those classified non-FP (N = 44, p = .892, z = -1.24, h = -.17). The Overall-adjusted Fisher exact p = .001 (*phi* = .34). In PRL-2, the FP success rate was 36% (N = 44, p = .075, z = 1.44, h = .23) and 35% of the nonFP subjects were successful (N = 60, p = .054, z = 1.61, h = .22). The Overall-adjusted Fisher exact p = .472 (*phi* = .01).

In the FRNM series, 40% of the FP subjects had hits (N = 42, p = .02, z = 2.06, h = .33), compared to 25% for the nonFP subjects (N = 60, p = .5, z = 0.00, h = .00). The Overall-adjusted Fisher exact p = .0499 (*phi* = .16).

Table 5 summarizes the results across all three studies. The FP subjects show significant performance (N = 127, p = .000064, z = 3.83, h = .38). The 95% confidence interval for the mean success rate of 42% is from 34% to 49%. NonFP show nonsignificant overall performance, with a hit rate of 27% (N = 164, p = .33, z = 0.44, h = .035); the 95% CI is from 20% to 34%. The difference in overall success rates between FP and nonFP subjects is also significant (z = 2.69, p = .0036). Using meta-analytic techniques for combining correlations (Hedges and Olkin, 1985), the

Table 5. MBTI Feeling/Perception (FP)

FP?	Study	N	% hits	95% CI From	95% CI To	Effect size (h)	z	p
Yes	PRL-1	40	50	37	64	.52	3.25	.00057
	PRL-2	45	36	23	48	.23	1.44	.075
	FRNM	42	40	27	54	.33	2.06	.02
	Combined	127	42	34	49	.38	3.83	.000064
No	PRL-1	44	18	5	31	-.17	-1.24	.892
	PRL-2	60	35	24	46	.22	1.61	.054
	FRNM	60	25	14	36	.00	0.00	.500
	Combined	164	27	20	34	.035	0.44	.33
Difference in proportions (Combined FP vs No FP)							2.69	.0036

Table notes. Percent hits and confidence estimates are rounded to nearest percentage point. Combined effect sizes and Stouffer's zs are weighted by study sample sizes. FP/no FP difference is based on a z-test for binomial proportions using the combined (sample size weighted) estimates for each group.

Table 7. The Three Factor Model

Psi+FP+Mental Disciplines?	Study	N	% Hits	95% CI From	95% CI To	Effect Size (h)	z	p
	PRL-1	49	18	6	31	-.16	-1.26	.895
No	PRL-2	67	37	27	48	.27	2.12	.017
	FRNM	74	27	17	37	.05	0.29	.386
	Combined	190	28	20	38	.07	0.92	.179
	PRL-1	34	56	41	70	.64	3.67	.00012
Yes	PRL-2	37	32	19	46	.17	0.86	.194
	FRNM	28	43	26	62	.38	1.89	.029
	Combined	99	43	35	52	.39	3.64	.00014
Difference (Combined Yes vs. No)							2.64	.0041

Table notes. Percent hits and confidence estimates are rounded to nearest percentage point. Combined effect sizes and Stouffer's zs are weighted by study sample sizes. Confidence intervals for subsets with $N \leq 30$ are based on Blyth & Still (1983). Yes/No difference is based on a z-test for binomial proportions using the combined (sample size weighted) estimates for each group.

prior psi testing experience, only 15 participants satisfied the four-predictor model (reported psi experiences, FP, mental disciplines, and prior testing) in the three studies. Nevertheless, the results are rather striking. In PRL-1 hits were obtained by six of the seven participants satisfying all four factors (p = .0013, z = 3.00, h = 1.32). Three out of four were successful in PRL-2 (p =.0508, z = 1.64, h = 1.05). In the FRNM series, hits were obtained by two of the four participants satisfying all four factors. Combining across the three studies, 11 of the 15 participants correctly identified their targets (73% hits, weighted z = 3.35, p = .00041). The overall effect size (h weighted by sample size) is = 1.03.

The Three-Predictor Model

Due to the extremely small number of cases satisfying the four-predictor model, Honorton & Schechter (1987) and Broughton, et al., (in press) focused on a three-factor model, excluding prior psi testing. Combining the three studies, 99 participants satisfied the three-predictor model (reported psi experiences, FP, and involvement with mental disciplines). In PRL-1, 34 participants satisfied the three-factor model. They achieved a success rate of 56% (p = .00012, z = 3.67, h = .64) and the 95% CI is from 41% to 70%. An 18% success rate was obtained by the 49 PRL-1 participants not satisfying the three-factor model, but for whom data on all three factors is available (p = .895, z = -1.26, h = -.16, 95% CI from 6% to 31%). This pattern was slightly reversed in PRL-2 with a success rate of 32% for those satisfying the model (N = 37, p = .194, z = 0.86, 95% CI from 19% to 46%) and a 37% success rate for those who did not satisfy it (N = 67, p = .017, z = 2.12, h = .27, 95% CI from 27% to 48%). In the FRNM study, 28 participants satisfied the model with a success rate of 43% (p = .029, z = 1.89, h = .38, 95% CI from 26% to 62%). A success rate of 27% was obtained by the 74 FRNM participants who did not satisfy the model (p = .386, z = 0.29, h = .07, 95% CI from 17% to 37%).

Table 7 summarizes the results of all three studies. Overall, the three-factor model appears to show some promise. Altogether 99 novice participants in three studies satisfied the three-predictor model, with an overall success rate of 43% (z = 3.64, p = .00014, h = .39, 95% CI from 35% to 52%). The 191 participants not satisfying the model obtained a success rate of 28% (z = 0.92, p = .179, h = .07, 95% CI from 20% to 38%). The difference between the two groups is significant (z = 2.64, p = .0041) and the *phi* coefficient is .15.

Discussion

While none of the predictors individually differentiated successful versus unsuccessful performance in each of the three studies, significant hitting across all three studies was limited to participants meeting the criteria for each of the individual predictors. From a purely pragmatic point of view, if we were advising new

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APPENDIX C

Impact of the Sender in Ganzfeld Communication: Meta-Analysis and Power Estimates

Impact of the Sender in Ganzfeld Communication: Meta-Analysis and Power Estimates

Charles Honorton

Psychophysical Research Laboratories and The University of Edinburgh

Abstract: This report provides a quantitative review of all available studies of information retrieval via real-time ganzfeld imaging techniques reported in the English-language parapsychological literature between 1974-1991. The review estimates the magnitude of the effect overall and as a function of target presentation conditions (presence or absence of a target observer or sender). The resulting estimates are used in a statistical power analysis to determine optimal sample sizes for maximising successful detection of ganzfeld communication in new studies.

Keywords: Ganzfeld, meta-analysis, parapsychology, power analysis.

Description of the Domain

In the early 1970s a number of investigators were led independently to explore the effects of a perceptual isolation technique (ganzfeld stimulation) on performance in anomalous communication tasks (Braud, Wood, & Braud, 1975; Honorton & Harper, 1974; Parker, 1975). The impetus for this research involved converging evidence that anomalous communication effects were frequently associated with internal attention states characterised by reduced perceptual processing (see Honorton, 1977). A homogeneous visual field (ganzfeld) is produced through diffusion of a bright light source over translucent hemispheres covering the receiver's eyes. Homogeneous auditory stimulation is produced by white noise through headphones. The receiver usually undergoes relaxation exercises at the beginning of the session, then free-associates to describe a randomly selected and remotely located target. The target usually is viewed by a sender who attempts to communicate salient features of its content or meaning to the receiver; in studies without a sender, the target is enclosed in an opaque container. Assessment typically involves blind-ranking or rating similarities between the receiver's ganzfeld-produced imagery and a pool including the target and several decoys.

The Standard Analysis Method

In the prototypical ganzfeld imaging study, receivers attempt to identify the target by ranking perceived similarities between their ganzfeld generated imagery and a judging pool consisting of the target and several decoys. This judging task is "double-blind," such that neither receiver nor experimenter knows the identity of the correct target. Success is defined in terms of the binomial probability associated with the proportion of

Table 1. Overall Results

	N studies	N investi-gators	Median sample size	Mean effect size	95% confidence interval From	To	z	p	Fail-Safe Ratio
All studies	73	21	32	0.16	.06	.26	5.74	4.75×10^{-9}	11 to 1
Direct hits studies	53	16	30	0.23	.13	.33	6.75	7.43×10^{-12}	16 to 1

Results

Overall Effect

A total of 73 studies were retrieved. These studies were conducted by 21 independent research teams and involve 4,155 trials contributed by 1,762 subjects. Table 1 summarizes the overall ganzfeld study outcomes. The combined z-score is 5.74 ($p = 4.75 \times 10^{-9}$). Rosenthal's (1991) 'Fail-Safe N' estimate indicates that approximately 11 unreported studies averaging null outcomes would be required to reduce the overall significance of the retrieved studies to p=.05. The mean effect size is .16 (95% CI = .06/.26). The mean effect size is equivalent to a success-rate of 32.2% in the standard 4-choice situation. The last row of Table 1 gives the same breakdown for the largest subset of studies involving analysis by direct hits. These studies were contributed by 16 independent research teams and the combined z = 6.75 ($p = 7.43 \times 10^{-12}$). The 'Fail-Safe' estimate indicates that approximately 16 unretrieved studies averaging null outcomes would be required to jeopardise the significance of this subset. The mean

Table 2. Statistical Power Analysis for Overall Results

	All Studies	Direct Hits Studies
Power Estimate (using average ES & sample size)	0.23	0.35
Expected N Studies Significant at $p = .05$, given power estimate	17	19
Observed N Studies significant	19	15
Z(Observed vs. Expected)	0.49	-1.17
$p(Z)$	.31	.88

Table 3. Studies with and without Senders

	N studies	*N* investi-gators	Median sample size	Mean effect size	95% confidence interval From	To	*z*	*p*	Fail-Safe Ratio
Sender	61	20	30	0.17	.07	.27	5.70	6×10^{-9}	11 to 1
No Sender	12	7	33.5	0.10	-.10	.30	1.31	.095	–
Difference							1.49	.137	

with and without senders (Tukey, 1977). A statistical summary is provided in Table 3. Senders were employed in 61 studies (3,684 trials) by 20 independent investigators. The combined *z*-score is 5.70 ($p=7 \times 10^{-9}$). Rosenthal's 'Fail-Safe N' estimate indicates that approximately 11 unreported studies averaging null outcomes would be required to reduce the overall significance of the retrieved studies to $p=.05$. The mean effect size of .17 is equivalent to a success rate of 32.5% in the typical 4-choice situation and the 95% CI = .07/.27, i.e., 28%/37%.

The remaining 12 studies (470 trials) did not employ senders. These studies, contributed by seven independent investigators, have a combined $z = 1.31$ ($p=.095$). The mean effect size is .10 (95% CI = -.10/.30). Thus, the studies without senders show no overall evidence for anomalous communication.

Transforming the mean effect sizes for studies with and without senders back to proportion of hits, the difference between the two conditions was tested using the *z* test for differences between binomial proportions. The resulting *z* of 1.49 is nonsignificant ($p = .1371$, two-tailed). The effect size for the difference is .023. While this difference is not significant, only the studies with senders show a significant overall ganzfeld communication effect.

Since the sender/no sender comparison is between rather than within studies, i.e., not based on systematic within study comparison of sender impact, the observed difference could be due to factors other than the presence or absence of senders. Investigators tend to implement experimental procedures in various ways, sample from different populations (e.g., students, volunteers), employ various instructional sets, and use a variety of different target stimuli. Such variations could conceivably account for the observed differences.

To assess this possibility, an analysis was performed on the subset of five investigators who contributed both studies with senders and without senders. This subset comprises only about 20% of the investigator base, but 40% of the total number of trials (N = 1,666). These investigators reported 25 studies with senders (N = 1,497,

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studies were not designed to systematically assess sender versus no sender conditions, the meta-analysis cannot address the underlying source of this difference. New studies, specifically designed to compare sender/no sender effects, will be needed to assess the extent to which the sender's influence is instrumental (intrinsic to the communication process) or peripheral (based on psychological or motivational factors).

1/or determines "data type."

References

Braud, W. G., Wood, R., & Braud, L. W. (1975). Free-response GESP performance during an experimental hypnagogic state induced by visual and acoustic ganzfeld techniques. A replication and extension. *Journal of the American Society for Psychical Research*, **69**, 105-113.

Cohen, J. (1977). *Statistical power analysis for the behavioral sciences* (rev. ed.). New York: Academic Press.

Honorton, C. (1975). Objective determination of information rate in psi tasks with pictorial stimuli. *Journal of the American Society for Psychical Research*, **69**, 353-359.

Honorton, C. (1977). Psi and internal attention states. In B. B. Wolman (Ed.), *Handbook of parapsychology*. NY: Van Nostrand Reinhold. (pp. 435-472).

Honorton, C., & Harper, S. (1974). Psi-mediated imagery and ideation in an experimental procedure for regulating perceptual input. *Journal of the American Society for Psychical Research*, **68**, 156-168.

Parker, A. (1975). Some findings relevant to the change in state hypothesis. In J. D. Morris, W. G. Roll, & R. L. Morris (Eds.) *Research in Parapsychology, 1974*. Metuchen, NJ: Scarecrow Press. (pp. 40-42).

Rosenthal, R. (1991). *Meta-analytic procedures for social research* (rev. ed.). Newbury Park: Sage.

Solfvin, G. F., Kelly, E. F., & Burdick, D. S. (1978). Some new methods of analysis for preferential-ranking data. *Journal of the American Society for Psychical Research*, **72**, 93-110.

Stanford, R. G., & Sargent, C. L. (1983). Z scores in free-response methodology: Comments on their utility and correction of an error. *Journal of the American Society for Psychical Research*, **77**, 319-326.

Tukey, J. W. (1977). *Exploratory data analysis*. Reading, MA: Addison-Wesley.

Honorton, C., Berger, R. E., Varvoglis, M. P., Quant, M., Derr, P., Schechter, E. I., & Ferrari, D. C. (1990). Psi communication in the ganzfeld: Experiments with an automated testing system and a comparison with a meta-analysis of earlier studies. *Journal of Parapsychology*, **54**, 99-139.

Honorton, C., & Harper, S. (1974). Psi-mediated imagery and ideation in an experimental procedure for regulating perceptual input. *Journal of the American Society for Psychical Research*, **68**, 156-168.

Houtkooper, J. M., Gissurarson, L. R., & Haraldsson, E. (1988-89). Why the ganzfeld is conducive to ESP: a study of observational theory and the participant-order effect. *European Journal of Parapsychology*, **7**, 169-192.

Kanthamani, H., & Khilji, A. (1990). An experiment in ganzfeld and dreams: a confirmatory study. *Proceedings of Presented Papers of the 33rd Annual Convention of the Parapsychological Association*, 126-137.

Kanthamani, H., Khilji, A., & Rustomji-Kerns, R. (1989). An experiment in ganzfeld and dreams with a clairvoyance technique. In L. Henkel & J. Palmer (Eds.), *Research in Parapsychology, 1988*. Metuchen, NJ: Scarecrow Press. (pp. 84-88.)

Keane, P., & Wells, R. (1979). An examination of the menstrual cycle as a hormone related physiological concomitant of psi performance. In W. G. Roll (Ed.), *Research in Parapsychology, 1978*. Metuchen, NJ: Scarecrow Press. (pp. 72-74.)

Milton, J. (1986). *Displacement effects, role of the agent, and mentation categories in relation to ESP performance*. Unpublished Ph.D. thesis, University of Edinburgh.

Munson, R. J., Kanthamani, H., Khilji, A., & Zingrone, N. L. (1988). FRNM ganzfeld: an attempted replication. In L. A. Hinkel & R. E. Berger (Eds.), *Research in Parapsychology, 1987*. Metuchen, NJ: Scarecrow Press (pp. 44-47.)

Murre, J. M., van Dalen, A. C., Dias, L. R., & Schouten, S. A. (1988). Ganzfeld psi experiments with a control condition. *Journal of Parapsychology*, **52**, 103-126.

Palmer, J., & Aued, I. (1975). An ESP test with psychometric objects and the ganzfeld: negative findings. In J. D. Morris, W. G. Roll, & R. L. Morris (Eds.) *Research in Parapsychology, 1974*. Metuchen, NJ: Scarecrow Press (pp. 50-53).

Palmer, J., Bogart, D. N., Jones, S. M., & Tart, C. T. (1977). Scoring patterns in an ESP ganzfeld experiment. *Journal of the American Society for Psychical Research*, **71**, 121-145.

Palmer, J., & Kanthamani, H. (1990). A ganzfeld experiment with subliminal sending. *Proceedings of Presented Papers of the 33rd Annual Convention of the Parapsychological Association*, 227-242.

Smith, M., Tremmel, L., & Honorton, C. (1976). A comparison of psi and weak sensory influences on ganzfeld mentation. In J. D. Morris, W. G. Roll, & R. L. Morris (Eds.) *Research in Parapsychology, 1975*, Metuchen, NJ: Scarecrow Press (pp. 191-194.)

Sondow, N. (1979). Effects of associations and feedback on psi in the ganzfeld: is there more than meets the judge's eye? *Journal of the American Society for Psychical Research*, **73**, 123-150.

Sondow, N. (1987). Exploring hypnotizability, creativity, and psi: conscious and unconscious components to psi success in the ganzfeld. In D. H. Weiner & R. D. Nelson (Eds.) *Research in Parapsychology, 1986*. Metuchen, NJ: Scarecrow Press. (pp. 42-47.)

Sondow, N., Braud, L., & Barker, P. (1981). Target qualities and affect measures in an exploratory psi ganzfeld. In W. G. Roll, R. L. Morris, & R. White (Eds.), *Research in Parapsychology, 1980*. Metuchen, NJ: Scarecrow Press (pp. 82-85).

Stanford, R. G. (1979). The influence of auditory ganzfeld characteristics upon free-response ESP performance. *Journal of the American Society for Psychical Research*, **73**, 253-272.

Stanford, R. G., & Angelini, R. (1984). Effects of noise and the trait of absorption on ganzfeld ESP performance. *Journal of Parapsychology*, **48**, 85-100.

Stanford, R. G., Frank, S., Kass, G., & Skell, S. (1989). Ganzfeld as an ESP-favorable setting: part II. *Journal of Parapsychology*, **53**, 95-124.

Stanford, R. G., & Neylon, A. (1975). Experiential factors related to free-response clairvoyance performance in a sensory uniformity setting (ganzfeld). In J. D. Morris, W. G. Roll, & R. L. Morris (Eds.) *Research in Parapsychology, 1974*, Metuchen, NJ: Scarecrow Press (pp. 89-93.)

Terry, J. C. (1976). Comparison of stimulus duration in sensory and psi conditions. In J. D. Morris, W. G. Roll, & R. L. Morris (Eds.) *Research in Parapsychology, 1975*, Metuchen, NJ: Scarecrow Press (pp. 179-181).

Terry, J. C., Tremmel, L., Kelly, M., Harper, S., & Barker, P. (1976). Psi information rate in guessing and receiver optimization. In J. D. Morris, W. G. Roll, & R. L. Morris (Eds.) *Research in Parapsychology, 1975*, Metuchen, NJ: Scarecrow Press (pp. 194-198.)

Terry, J. C., & Honorton, C. (1976). Psi information retrieval in the ganzfeld: two confirmatory studies. *Journal of the American Society for Psychical Research*, **70**, 207-217.

Wood, R., Kirk, J., & Braud, W. (1977). Free response GESP performance following ganzfeld stimulation vs. induced relaxation, with verbalized vs. nonverbalized mentation: a failure to replicate. *European Journal of Parapsychology*, **1**, 80-93.

APPENDIX D

Effects of the Sender on Anomalous Communication in the Ganzfeld

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Effects of the Sender on Anomalous Communication in the Ganzfeld

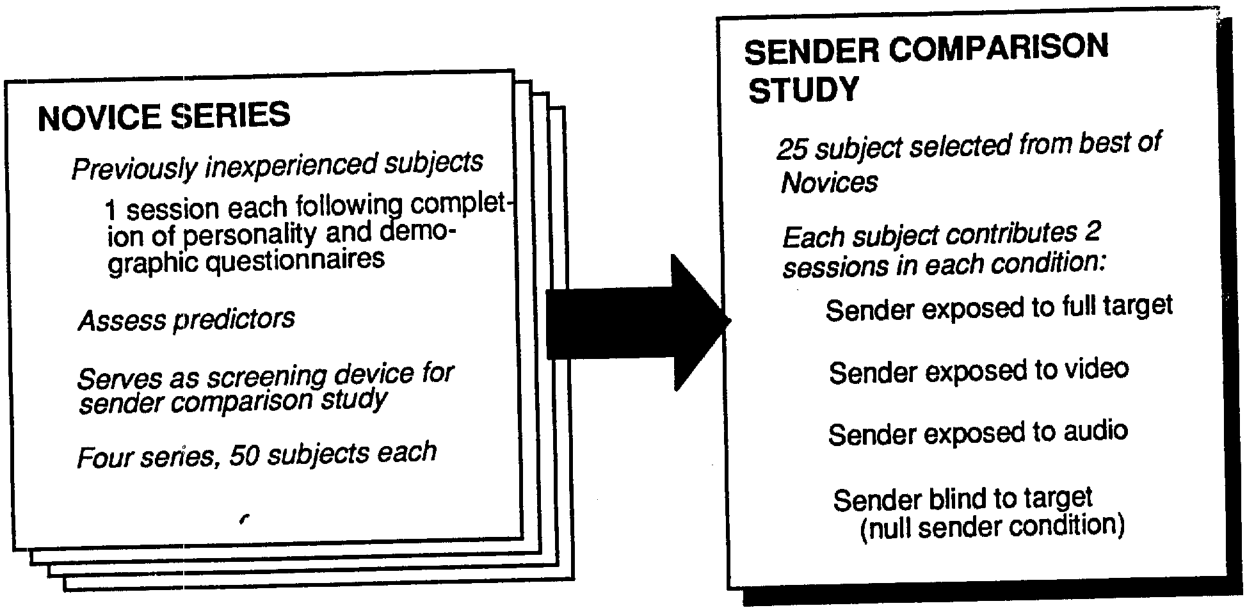
Research Protocol

Charles Honorton

Psychophysical Research Laboratories and the University of Edinburgh

both visual and auditory components, enabling comparison of four conditions: Video+audio ("Full target") components presented to sender, Video only, Audio only, neither component ("Null sender" condition). The specific condition for a given session is randomly selected and unknown to either experimenter or subject until the end of the session. (See Figure 1.)

Figure 1. Study Design



Video Ganzfeld System

The video ganzfeld system is a second-generation hardware/software control system for the study of anomalous communication in the ganzfeld. It is essentially an updated version of the PRL automated ganzfeld system (Honorton, et al., 1990), providing automated computer control of major aspects of the ganzfeld session, including:

- Random selection of the target in novice series
- Random selection of sender condition in sender comparison series
- Automated VCR control and presentation of the target (or target element) to the sender during sending periods
- Presentation of judging pool (target and decoys) to receiver (subject) and experimenter during the post-session blind-judging procedure
- Presentation of judging rating scales and registration of blind-judging responses
- Data recording and storage
- Automated presentation of subject feedback following blind-judging and data recording

The system also includes modules controlling series design and subject registration which are described below.

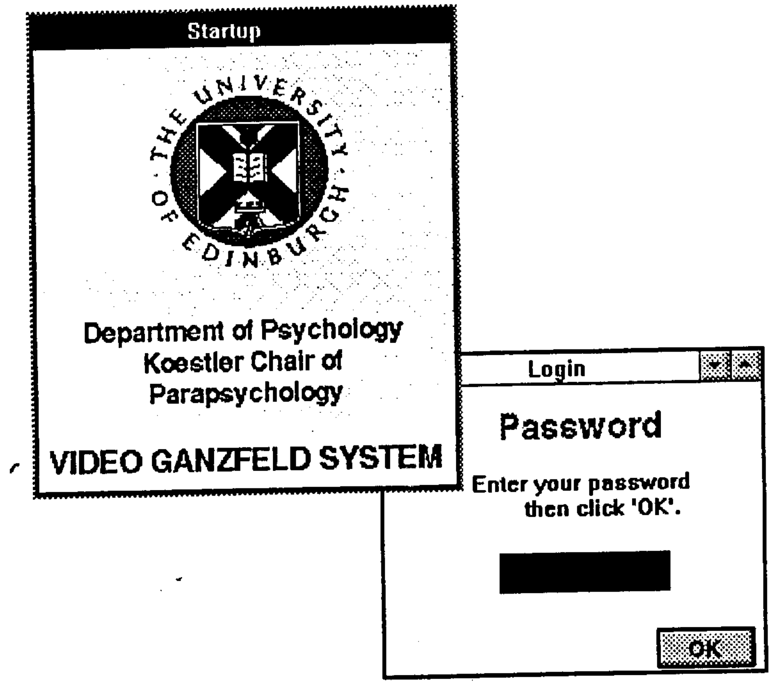
Hardware System

The video ganzfeld system runs under Microsoft Windows 3.1/DOS 5 on a 33MHz 80386DX computer. The computer is equipped with 210 MB fixed disk, 8 MB DRAM, four RS 232 serial ports, an 80387 numeric coprocessor, and a super VGA monitor. The video subsystem has onboard

Software System

The video ganzfeld software runs under Microsoft Windows 3.1. The initial startup sequence requires the experimenter to enter a valid security password. (See Figure 3.) The system automatically terminates if a valid password has not been entered.

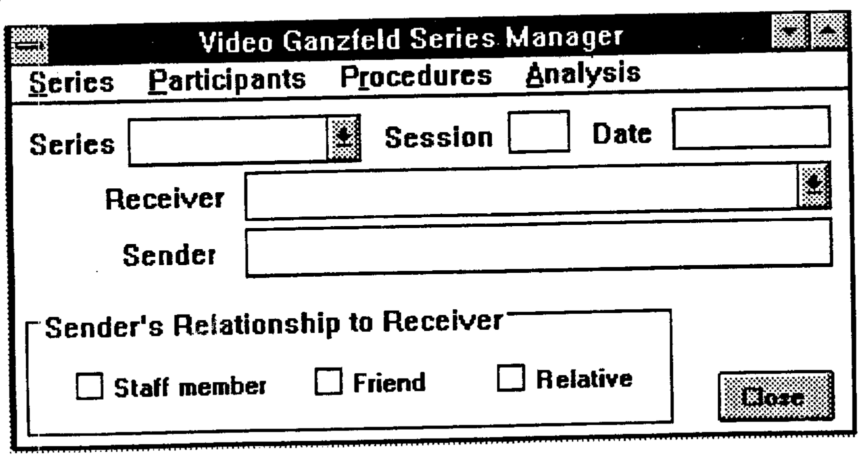
Figure 3. System Startup Sequence



Series Manager

Upon entry of a valid password, the Series Manager is loaded. Series Manager is the central control program. It enables the experimenter to design new experimental series, register new subjects, run experimental sessions, and export data files to database management packages. (See Figure 4.)

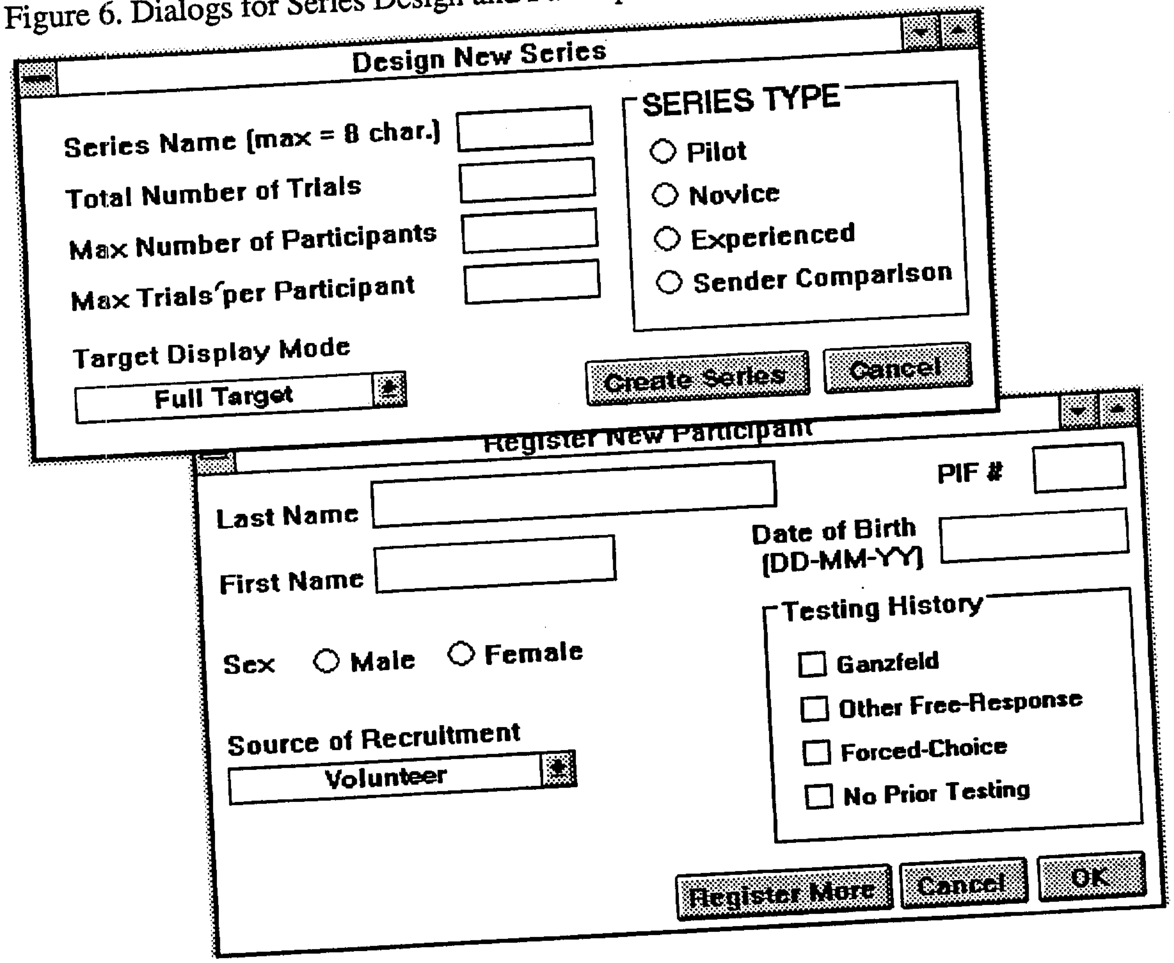
Figure 4. Video Ganzfeld Series Manager



The Series Manager menu structure is shown in Figure 5. Each of the major menu components is described below.

The Participant Registration option provides the only valid means by which new participants can enter an experimental series. Upon selecting this option, the experimenter is presented with a dialog box which prompts him to enter the subject's name, a unique identification (PIF) number, the participant's sex, date of birth, source of recruitment into the study (from a standardized list), and prior testing history. As with the Series Design dialog, data input validation routines are used to insure appropriate input and check for contradictions (e.g., checking "No prior testing" and one of the other prior testing options). The Series Design and Participant Registration dialogs are shown in Figure 6.

Figure 6. Dialogs for Series Design and Participant Registration



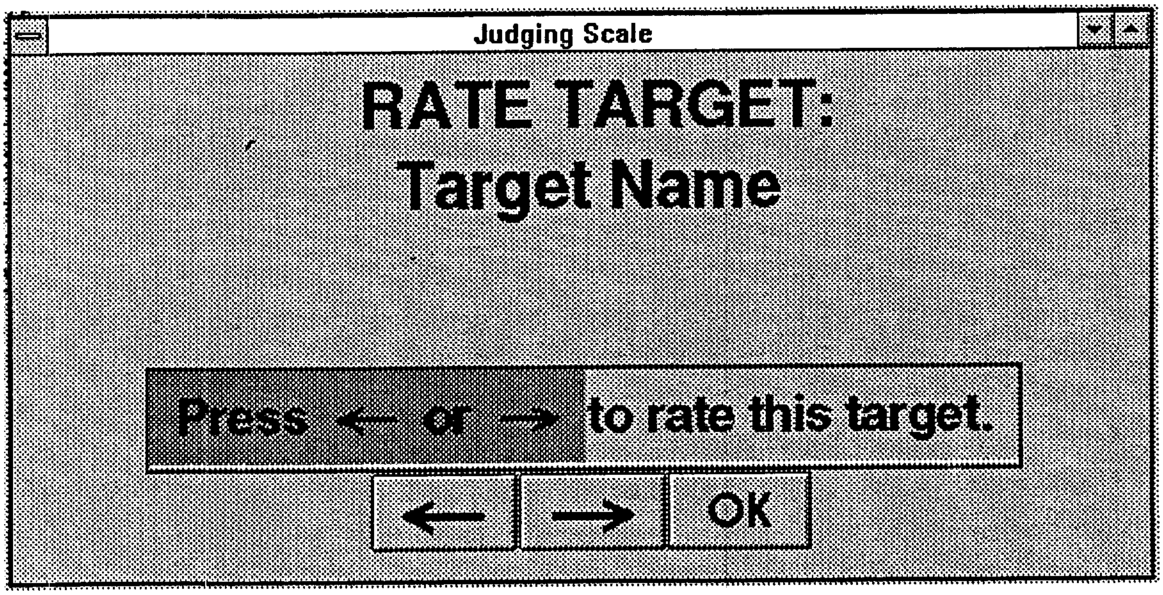
Procedures

The primary options available on the Procedures menu enable the experimenter to run a session and to initiate the blind-judging procedure at the end of the session.

When the experimenter selects "Run Session" from this menu, Series Manager opens a Session Controller window (Figure 7).

random sequences. The receiver is prompted to identify whatever correspondences they perceive between their ganzfeld mentation and each of the four potential targets. The receiver is given the option to view any or all of the elements in the judging pool as many times as desired, then procedes to perform the blind judging task. The program displays a judging scale (Figure 8) on the receiver's monitor for each of the four possible targets in the judging pool. The judging scale shows a brief descriptive name for each target, a thermometer-style rating scale, and three buttons. Using a mini-joystick, the receiver rates the degree of perceived similarity between each potential target and their mentation. The scale ranges from 0% to 100% and the current value of the scale is displayed both numerically and graphically as the receiver clicks either the left or right arrow buttons.

Figure 8. Video Ganzfeld Judging Scale



When the receiver is satisfied with the rating assigned, she or he presses the "OK" button. The judging procedure is repeated for each of the four potential targets in the judging pool. The program checks for tied ratings and prompts the receiver to re-rate in the event of a tie. Once the receiver has rated all of the elements in the judging pool, the program converts the ratings to ranks and stores the ratings and ranks as fields in the session database record. The program calculates a standardized rating (*z*-score) based on the difference between the rating assigned to the correct target and the mean of the three decoy ratings divided by the standard deviation of of all four ratings (Stanford & Sargent, 1983).

The program times the duration of the judging procedure from initial presentation of the four judging pool elements to completion and adds it to the session database record.

The Series Manager Procedures menu includes three additional options: "Abort current session," "Session log," and "Check System." The abort session option is

- Identification of elements of target environments that may be especially amenable to retrieval via anomalous communication.

Recently, major advances have been made with regard to certain aspects of this problem as it specifically applies to remote viewing studies (May, et al., 1985; 1990). While aspects of May's conceptual schema can also be applied to ganzfeld research, there are two aspects of the latter that call for a somewhat different approach: (1) The standard ganzfeld mentation protocol focuses upon the elicitation of unconstrained spontaneous imagery rather than an explicit focus upon describing the target. (2) The video targets are themselves quite different from those typically used in remote viewing research: They include auditory components (e.g., music, dialogue, narration, sound effects), occasionally major transitions in perspective, highly evocative dramatic and comedic scenes, etc.

For these reasons, we have adopted a somewhat different approach, consisting of two distinct aspects: (1) Specific descriptors tailored to the content of the target pools, and (2) generic characteristics derived from environmental psychology.

Content-based Descriptors

Each target has been coded with respect to Theme, Tone, and Content. Each item is coded

Table 1. Content-based Descriptors

THEMES	Nature/wildlife Fantasy/religion/mythology Aggression/battles/warfare/conflict Social interactions Sports/athletics/acrobatics Art/dance/music Places/travel/exploration Cartoons/animation
TONE	Humor Documentary Action Drama Wonderment/awe Light entertainment
CONTENT	People Animals Fantasy/mythical characters Water Rocks/hills/mountains Trees/flowers/foliage Land vehicles/scenes Terrestrial flight scenes Underwater vehicles/scenes Architecture/urban scenes Technology/objects/devices/tools Space/planets/galaxies Music

Predictor Measures

Extraversion and Openness to Experience

Performance in anomalous communication tasks has been found to correlate with the psychological trait of extraversion in a recent meta-analysis of 15 studies by five independent investigators (Honorton, Ferrari, & Bem, 1990). The mean correlation is small (r = .20) but consistent across investigators, studies, and personality measures.

While the meta-analysis provides strong evidence that a relationship exists between anomalous communication and extraversion, it is silent as to the nature of the relationship. Extraversion is commonly associated with sociability (gregariousness), but it is now known that there are at least five other components of extraversion. For this reason, we have chosen the NEO Personality Inventory (Costa & McRae, 1985), an instrument that measues six facets of extraversion. Recent research implicates sensation seeking as an instrumental factor in the ganzfeld experience (Glicksohn, 1991) and we are especially interested in the possibility that it also correlates with performance in anomalous communication tasks. We also will use the NEO PI Openness scale, and its six facets, because a number of studies have indicated a relationship between anomalous communication and various measures of openness to experience. Table 2 lists the six facets of extraversion and openness.

Table 2. Facets of Extraversion and Openness

Scale	Facet
EXTRAVERSION	1. Warmth 2. Gregariousness 3. Assertiveness 4. Activity 5. Excitement Seeking 6. Positive Emotions
OPENNESS	1. Fantasy 2. Aesthetics 3. Feelings 4. Actions 5. Ideas 6. Values

A computer program scores the questionnaire and presents graphic profiles for each of the six facets of extraversion and openness. Statistical power analysis (Cohen, 1977) indicates that a sample size of 200 subjects will achieve a 90% likelihood of detecting a correlation of .2 at $p<.05$. With $N \geq 200$, the critical value of r ($p \leq .05$) is within the 95% CI of the meta-analysis.

Other Moderators

Honorton, C. (in press). The ganzfeld novice: Four predictors of initial ESP performance. *Proceedings of the 35th Annual Convention of the Parapsychological Association.* Research Triangle Park, NC: Parapsychological Association.

Honorton, C., Berger, R. E., Varvoglis, M. P., Quant, M., Derr, P., Schechter, E. I., & Ferrari, D. C. (1990). Psi communication in the ganzfeld: Experiments with an automated testing system and a comparison with a meta-analysis of earlier studies. *Journal of Parapsychology*, **54**, 99-139.

Honorton, C., Ferrari, D. C., & Bem, D. J. (1990). Extraversion and ESP performance: A meta-analysis and a new confirmation. *Proceedings of the 33rd Annual Convention of the Parapsychological Association.* Research Triangle Park, NC: Parapsychological Association, 113-125.

May, E. C., Humphrey, B. S., & Mathews, C. (1985). A figure of merit analysis for free-response material. *Proceedings of the 28th Annual Convention of the Parapsychological Association.* Research Triangle Park, NC: Parapsychological Association, 343-354.

May, E. C., Utts, J. M., Humphrey, B. S., Luke, W. L. W., Frivold, T. J., & Trask, V. V. (1990). Advances in remote-viewing analysis. *Journal of Parapsychology*, **54**, 193-228.

Mehrabian, A., & Russell, J. A. (1974). *An approach to environmental psychology.* Cambridge: MIT Press.

Schlitz, M. J., & Honorton, C. (1992). Ganzfeld psi performance within an artistically gifted population. *Journal of the American Society for Psychical Research*, **86**, 83-98.

Stanford, R. G., & Sargent, C. L. (1983). Z scores in free-response methodology: Comments on their utility and correction of an error. *Journal of the American Society for Psychical Research*, **77**, 319-326.

II. Information Rate

Instructions: Please use the following adjective pairs to describe the situation depicted in the target episode. Each of the following adjective pairs helps define the situation or the relation among the various parts of the situation. Put a check mark in one of the boxes to indicate what you think is an appropriate description.

Varied										Redundant
Simple										Complex
Novel										Familiar
Small-scale										Large-scale
Similar										Contrasting
Dense										Sparse
Intermittent										Continuous
Usual										Surprising
Heterogeneous										Homogeneous
Uncrowded										Crowded
Asymmetrical										Symmetrical
Immediate										Distant
Common										Rare
Patterned										Random

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APPENDIX E

A Preliminary Study of Anomalous Perception During Lucid Dreaming

A Preliminary Study of Anomalous Perception during Lucid Dreaming[1]

Stephen LaBerge, Ph.D.
The Lucidity Institute, Inc.

Several studies (reviewed in Child, 1985) have found evidence supportive of the existence of anomalous perception in dreams. The protocols for attempting to elicit anomalous perception in dreams fall into three main categories.

The first type, which has accumulated the larget amount of data, referred to by Child as "general ESP," is known in the popular literature as "dream telepathy." This entails the use of two research subjects, a "sender" and a "receiver." The sender subject concentrates on target information while the receiver subject is in REM sleep, presumably dreaming. The subject's dream content report is later analyzed for correspondence with the target information.

The second category is "precogntion," anomalous perception of future events. In these studies, the sender subject does not select or concentrate on the target until the receiver subject has already attempted to dream about and report on it.

The third type of dream anomalous perception, of most relevance to the present investigation, is called "clairvoyance," referring to the information acquired without a human "sender" intermediate. The protocol requires that the information in the target is not known to the experimenters, so that none could inadvertently act as a "sender."

The use of lucid dreaming to study "clairvoyant" type anomalous perception in dreams may enhance the subjects' ability to acquire accurate information about a remote target. Lucid dreaming is dreaming with awareness that one is dreaming (LaBerge, 1985). In the lucid dream state, one can deliberately alter the course of the dream according to one's intentions. Thus, a subject attempting to "see" a target photograph could decide in a lucid dream to seek out a dream image of the target, rather than relying on the possibility of the target spontaneously appearing in the dream. Lucid dreaming anomalous perception trials might be more similar to waking anomalous perception trials in that in both the subject makes a deliberate attempt to concentrate on and describe a remote stimulus.

This pilot experiment was designed to explore the potential for using the REM lucid dreaming state (dreaming while knowing that one is dreaming) for anomalous perception.

Procedure

Training in Lucid Dreaming

The general strategy of this pilot study called for subjects to induce lucid dreams in which they dream about Remote Viewing (RV) targets (National Geographic scenes sealed in opaque envelopes). Thus, training in lucid dreaming was the first step.

The subjects were selected from 1) subjects in previous RV studies who had demonstrated above normal RV capability (source: SAIC), and 2) subjects who had in prior studies shown above normal ability to induce lucid dreams (LD) (source: LI). The previous RV subjects were

[1]FINAL REPORT: SAIC SUBCONTRACT NO. 29-92-0085-71

Results

Seven subjects successfully completed at least one trial, visiting, viewing and reporting on the appearance of the target in a lucid dream. Four subjects were from the RV group and three were from the LD group. Three subjects were female, four male. Data was collected from 21 trials. Individual subjects contributed 1-7 trials each (mean=3).

Rank order
See Table 2 and Figure 1 for the distributions of rank orders for Targets and Non-targets. Examination of Figure 1 suggests that Non-target ranks were randomly distributed, while Targets showed higher ranks than expected by chance. Sum of ranks statistics were computed for the combined trials (N=21) and also for individual subjects. For individual subject statistics, see Table 3. For the combined trials (N=21), a moderate effect size was obtained: ES=0.368 (z=1.685, p=.046).

Table 2. Distribution of rank orders for targets and non-targets.

Rank	Target N	% Targets	Non-target N	% Non-targets
1	7	33%	14	17%
2	5	24%	16	19%
3	3	14%	18	21%
4	4	19%	17	20%
5	2	10%	19	23%

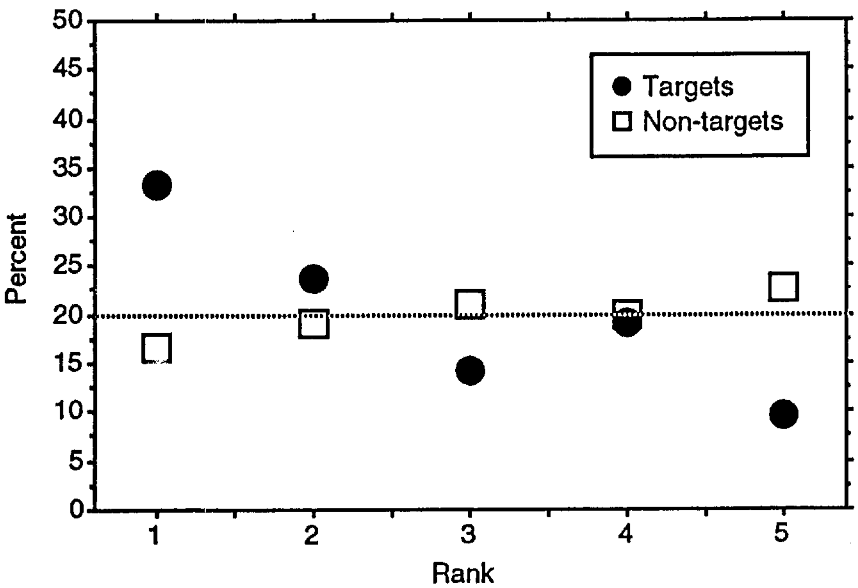

Figure 1. Rank orders for Targets vs. Non-targets. Dotted line represents theoretical (20%).

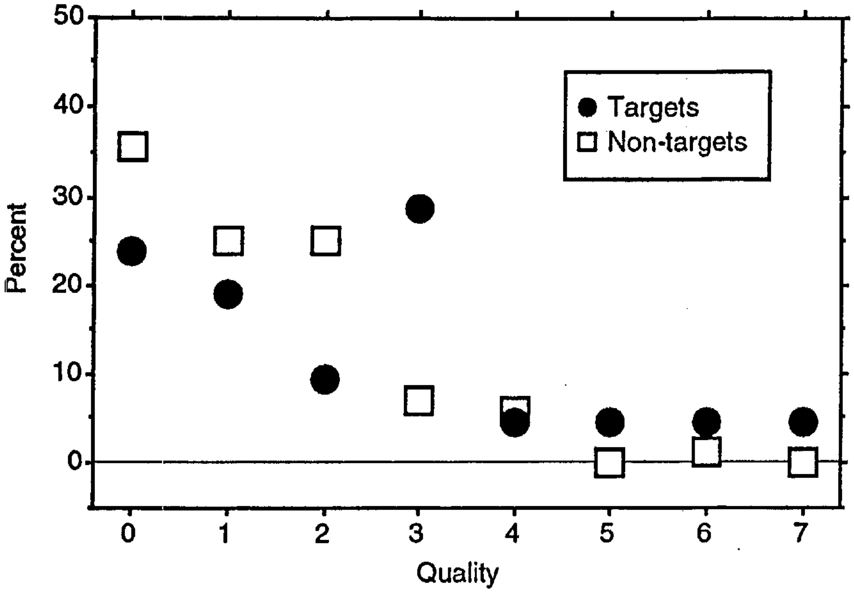

Figure 2. Quality Scores: Targets vs. Non-targets.

Three of the four RV subjects produced target viewing reports scoring 3 or better on quality, as did all three of the LD subjects. The sample size is too small to allow comparisons between the two groups.

Discussion

This study of the ability of people to report details of an unknown visual target examined remotely during the lucid dream state has shown promising results. The correspondence between the images of targets viewed in dreams and the actual target photographs was frequently enough greater than expected by chance to suggest a genuine transmission of information. The moderate to large effect sizes obtained in this preliminary study compare favorably to those acquired in other investigations demonstrating the remote viewing phenomenon (E. May & W. Luke, personal communication, 1992).

The sample size for this experiment was too small to be the basis for conclusions about the effectiveness of RV attempts in waking versus lucid dreaming. It can be said, however, that the lucid dream state allows access to this type of anomalous cognition. An example of a top ranking, high quality target "hit" will serve to demonstrate the nature of information acquired through AC in a lucid dream.

This trial was by a skilled lucid dreamer (S5) with no prior experience as a remote viewing subject. He slept with the target envelope in his bedroom. His report states,

> *"I realized I was dreaming [because X and Y were there; actually they are in Alaska]. The dream began to fade. I spun [technique for prolonging a dream] and arrived in my bedroom. The envelope was there, thick with much tape. I tore it open and dumped the contents on the bed. There were lots of odds and ends, which I decided to ignore, looking*

Several indications that certain features of lucid dream RV attempts tended to accompany successful trials appeared in the content of the lucid dream reports. Among these were: veridical dream representations of the subject's bedroom and the target envelope, the augmentation of pictorial information with written words or phrases and the assistance of dream characters helping the subjects to focus on the important elements of the dream imagery. To determine if these or other aspects of lucid dreaming trials are truly important for success, future experiments will direct and organize the subject's post trial reports with standardized questionnaires.

One reason for the small sample size in this study is the difficulty of training people to have lucid dreams at home. Subjects would be likely to produce more lucid dreams when sleeping the laboratory with stimuli applied while the subjects are in REM sleep to cue them to become lucid. Furthermore, the sleep laboratory situation would enable the experimenters to awaken subjects immediately after their lucid dream trials to collect the best possible reports of the dream target viewing. Therefore, it is recommended that subsequent studies of RV in the lucid dream state be conducted in a sleep laboratory with physiological monitoring of the parameters necessary for determining sleep states. This would also permit analysis of the EEG and other physiological measures that may correlate with successful RV.

References

Child, I.L. (1985). Psychology and anomalous observations: The question of ESP in dreams. American Psychologist, *40*, 1219-1230.

LaBerge, S. (1985). *Lucid dreaming.* Los Angeles: J.P. Tarcher.

APPENDIX F

Possible Effect of Geomagnetic Fluctuations on the Timing of Epileptic Seizures

TABLE 2--SEIZURE DATA

Patient ID	Period of data col.	No. of seizures	Seizure freq.	Epoch −1* t	Epoch −1 p	Epoch −2† t	Epoch −2 p	Epoch −1 r
TLG1	205	7	0.034	1.03	0.17	3.10	.01	0.359
TLG2	574	320	0.56	0.70	0.24	−0.28	.61	0.039
TLG3	182	42	0.23	−2.59	0.99	−3.08	.998	−0.382
TLG4	300	13	0.043	2.08	0.031	1.85	.045	0.518
TLG5	268	1449	5.4	0.41	0.34	−0.50	.69	0.011
TLG6	370	130	0.35	0.30	0.38	−1.87	.97	0.026
TLG7	482	11	0.023	0.06	0.48	−0.23	.59	0.018
TLG8	174	7	0.040	1.20	0.14	0.35	.37	0.412
TLG9	293	82	0.28	0.55	0.29	−1.13	.87	0.060
TLG10	323	17	0.053	−0.12	0.55	0.86	.20	−0.029
TLG11	180	49	0.27	0.48	0.32	0.17	.43	0.068
TLG12	182	17	0.094	0.79	0.22	2.80	.0064	0.187
TLG13	320	101	0.32	1.81	0.037	0.44	.33	0.178
TLG14	724	133	0.18	−2.08	0.98	−2.41	.99	−0.179
TLG15	2360	768	0.33	0.61	0.27	−0.62	.73	0.022
TLG16	166	71	0.43	0.93	0.18	0.40	.35	0.11
TLG17	185	12	0.065	−0.93	0.81	−0.02	.51	0.257
RR1	111	36	0.32	1.48	0.074	2.13	.020	0.241
NE1	87	167	1.9	−0.22	0.59	−0.28	.61	−0.017
NE2	5164	109	0.021	−1.15	0.87	−1.74	.96	−0.11
NE3	563	281	0.50	1.45	0.074	3.29	.00057	0.086
WO1	62	276	4.5	2.89	0.0021	3.64	.00016	0.172

*Epoch −1 refers to comparisons between the day of the seizures and previous days.

†Epoch −2 refers to comparisons with the day 2 days before the seizure day.

13 Ossenkopf K-P, Cain DP. Inhibitory effects of acute exposure to low-intensity 60-Hz magnetic fields on electrically kindled seizures in rats. *Brain Res* 1988; **442:** 255–60.

14 Adair RK. Constraints on biological effects of weak extremely-low-frequency electromagnetic fields. *Phys Rev A* 1991; **43(Pt 2):** 1039–48.

15 Bucha V. Solar and geomagnetic variability and changes of weather and climate. *J Atmos Terr Phys* 1991; **53(Pt 11):** 1161–72.

16 Mayaud PN. Derivation, meaning, and use of geomagnetic indices. *Geophys Monogr Ser* 1980; **22:** 1–154.

17 Cohen J. Statistical power analysis for the behavioral sciences. Hillsdale: Lawrence Erlbaum Associates, 1988.

18 Neppe VM, Tucker GJ. Neuropsychiatric aspects of seizure disorders. In: Yodofsky SC, Hales RE editors Textbook of Neuropsychiatry, 2 nd. Ed, Washington D.C.: American Psychiatric Press, pp 397–426.

19 Randall W. The solar wind and human birth rate: a possible relationship due to magnetic disturbances. *Int J Biometeorol* 1990; **34:** 42–8.

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Discussion

The hypothesized association between epileptic seizure occurrence and increased GMF activity on the seizure day was confirmed in this data. However the observed effect size for the interaction was very small ($r = 0.03$). For comparison Cohen[17] classifies effect sizes of less than 0.2 as small. Although this result has confirmed the earlier studies as regards the existence and direction of the GMF – seizure effect, the very small effect size observed and the absence of an established theoretical background for very low frequency EM fields as seizure promoters suggest that the present result should be treated cautiously. However the inhomogeneity of the sample of effect sizes suggests that there are uncontrolled factors effecting the interaction between GMF fluctuation and seizure occurrence. Whether these factors are characteristics of the patients or possibly of other environmental stimuli could not be determined in this study.

Research in neurobiology in general and epileptology in particular involves the almost impossible task of differentiating direct from indirect effects. Such unusual phenomena as seizures induced by tooth brushing or the smell of perfume but not foul odors exemplify the specificity of triggers in particular patients. Moreover, more general phenomena such as stress itself have been noted to increase the risk of seizures in many. These non-specific triggers may play only indirect roles by pathophysiologic cascades influencing neurotransmitter systems or electrical firing. Such phenomena[18] are even more difficult to determine because they may effect only a small proportion of epileptics.

These comments clearly have relevance with regard to geomagnetic influence. This could conceivably correlate with weather patterns. Cloudiness has been regarded as a possible correlate with depression. Heat intolerance can cause irritability. Indirect geomagnetic influences may turn out impossible to differentiate from direct ones but may lessen the power of tests to quantify statistically as other influences may also be confounding issues. Moreover, we know that certain patients may have their seizures triggered by events which do not influence others. Consequently, geomagnetism may play a role in a small proportion of patients and such actors as anticonvulsants may prevent this role powerfully. Thus, the profound results with the limited medicated patients may not be coincidental and serves as an excellent group for further research.

The decision not to control for anticonvulsant blood levels in our subjects merits further comment. Although serum concentrations of agents known to be pharmacologically

Results

GMF activity on the seizure days was compared with the activity of preceding days for the group of patients as a whole and for each patient separately. Grouping the data, the *Ap* index on the seizure day, 16.41 ± 20.2 nT, was slightly greater than for the preceding day, 16.01 ± 20.3 nT, (t [4100] = 1.84, p = 0.03). The index for the day prior to this, 16.09 ± 19.9 nT, was not significantly different from the seizure day (t [4100] = 0.55, p = 0.3). Neither was the index for the 10 days preceding the seizure, 16.43 ± 11.2 nT, significantly different from the seizure day index (t [4100] = 0.78, p = 0.2). The seizure diaries were recorded during intervals spanning the years 1977 to 1991 and covering more than one 11 year cycle of solar activity. Thus some diaries were recorded at periods of higher average GMF activity than others. For instance the mean *Ap* index for the 10 days prior to the seizure days for patient NE1 was 35.7 ± 16.9 nT, while that for TLG12 was 7.93 ± 2.1 nT. With the data combined into a single data set, GMF index changes between days will be masked by the large differences between the mean indices for the diaries. To avoid this, the differences in GMF index data between seizure and earlier days were analyzed for each patient separately. The results are shown in table II. The overall deviation from chance expectation for the group of patients can also be calculated from the individual patient's statistics by converting the t values to 1-tailed p values and then to z - scores which were combined by Stouffer's method. By this method, the *Ap* index for the seizure day was significantly greater than on the preceding day, (z = 2.48, p = 0.007) and greater, but not significantly so, than for the second day prior to the seizures (z = 1.21, p = 0.1), and for the mean daily index for the preceding 10 days (z = 1.08, p = 0.1). There is a wide range of patient t values ($-2.59 \leq t \leq 2.89$) present in the data. To analyze inter-patient differences, a measure of the difference in *Ap* index between the seizure days and the preceding days for each patient was defined which is independent of the number of seizures. The effect size $r = z / \sqrt{n}$ is such a measure, where z is the equivalent z - score for each patient's t value as computed above and n is the number of seizures recorded in the patient's diary. The overall effect size for the set of patients can be estimated as the weighted mean of the effect sizes and was found to be μ_r = 0.029 ± 0.016. This sample of 22 effect sizes was found to be inhomogeneous (χ^2 [21] = 33.3, p = 0.04) suggesting that the types of seizure or treatments represented in this data may exhibit intrinsically different responses to geomagnetic variations.

Methods

Patients

Seizure data consisting of dates, and in some cases times and dates, of seizures were obtained for a total of 22 patients. Data for patients 1 through 17 were collected from a study of the statistics of seizure timings.[1] This data, referred to as TLG, comprised diaries of patients on a stable regimen of antiepileptic medication who recorded the daily number of seizures along with details of unusual activities, stress and alcohol consumption. In the TLG study, data from three patients was split into subsets due to medication changes, loss of data recording for a period, or intervening surgery. In this study these patients' data was treated as a unit, identically to the other patients' data, since there was no *a priori* reason to expect that the data subsets used would show a differentiation of response to GMF variations. The remaining five patient's data was collected for this study and was more heterogeneous. Patient RR1 had all seizures recorded by her parents during a 4 month period under medical supervision but prior to medication being prescribed. After being administered sodium valproate her seizures stopped. Patients NE1 to NE3 had their seizures recorded partly as in-patients and partly at home. The completeness of these recordings is not known. Finally patient WO1's seizures were recorded by a family member during two periods and are thought to constitute a complete and accurate recording. All seizures submitted were included in the analysis, except those which occurred after September 30th 1991 when *ap* index data was not available. The clinical data is summarized in table I.

Insert table 1 about here

Geomagnetic Field Data

The 3 hour geomagnetic *ap* index[16] was used as the primary measure of GMF activity. This index provides an estimate of the range of variation of the intensity of the GMF, in nT, during a 3 hour interval of universal time (UTC). The index is also a spatial average across the globe; the actual range of field strength variation observed at any location may be greater than the *ap* range at high latitudes and smaller at low latitudes. The *ap* index is an integer value in the range [0, 400] with the variance of the index increasing during magnetic storms. Since this behavior can violate assumptions of homogeneity of variance needed for t test used

Introduction

The reasons for the precise timing of epileptic seizures in most patients remain largely unknown. Statistical studies of seizure timing have failed to identify clearly non-random patterns such as clustering or periodicity in many patients.[1,2] Several explanations for this have been suggested, including the postulation of an inherently random endogenous mechanism[3] and the possibility that seizure occurrence might be more or less tightly coupled to an exogenous variable which itself had nearly random statistics. In considering the second of these hypotheses several workers have looked for a suitable environmental stimulus in the very low frequency region of the electromagnetic (EM) spectrum. EM waves with frequencies of 10^4 Hz or less have several natural sources, including lightning discharges and ionospheric phenomena, and exhibit a complex distribution in time.[4] These long wavelength EM emissions are detectable everywhere on the globe and penetrate buildings and conducting structures with little attenuation. Additionally there is some evidence that such low frequency EM fields can interact with the functioning of biological systems, though the question is far from settled.[5,6] A connection between the triggering of epileptic seizure and low frequency EM radiation therefore has a certain *prima facie* plausibility.

Some reports have suggested that epileptic seizure frequency may be correlated with disturbances of the geomagnetic field (GMF).[7,8,9] Fluctuations in the GMF are primarily driven by changes in the sun's activity and major solar storms give rise to magnetic field changes of up to 1000 nT at the earth's surface and cover a range of frequencies from approximately 20 μHz to 10 Hz.[4] The literature on the effects of magnetic field exposure upon epileptic seizure, while not extensive, contains some suggestive avenues of research. Venkatraman[5] originally suggested that there might be an association between magnetic storms and epileptic attacks but did not provide any statistics to support this conclusion. Rajaram & Mitra[6] reported that monthly averages of admissions of epileptic cases rose during periods of increased GMF variation. However, no attempt was made to control for other factors which influence hospital admissions. According to Keshavan et al[7] a decrease in convulsive threshold in rats was observed during the GMF variation associated with a solar eclipse. Persinger[10] has suggested that increases in the GMF noise level suppress nocturnal melatonin levels, precipitating seizures and consequent cardiovascular instability. Significant correlations have also been reported between epileptic seizure onset and 10 kHz and 28 kHz atmospherics.[11] However a laboratory study of audiogenic seizure susceptible rats failed to find an association between EM at these frequencies and seizure timing.[12] There is also

Possible Effect of Geomagnetic Fluctuations on the Timing of Epileptic Seizures

JAMES SPOTTISWOODE ERIK TAUBØLL
MICHAEL DUCHOWNY VERNON NEPPE

ADDRESSES: Science Applications International Corporation, Cognitive Science Laboratory, 1010 El Camino Real Suite 330, Menlo Park, California 94025, USA (S.J.P.Spottiswoode, BSc); Department of Neurology, Rikshospitalet 0027, Oslo 1, Norway (E. Taubøll, MD); Department of Neurology, Miami Children's Hospital, Saloman Klein Pavilion, Miami, Florida 33155 USA (M.S.Duchowny, MD); Division of Neuropsychiatry, University of Washington, Seattle, Washington 98195 USA (V.M.Neppe, MD). Correspondence to S.J.P.Spottiswoode.

Running head: Geomagnetism and epileptic seizure.